Radiological Health Data

VOLUME IV, NUMBER 8

AUGUST 1963

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Public Health Service

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis and interpretation of data on environmental radiation levels. The Department delegated this responsibility to the Division of Radiological Health, Public Health Service.

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RADIOLOGICAL HEALTH DATA

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U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service • Division of Radiological Health

SECTION I.—AIR AND FALLOUT

Fission Product Beta Activity in Airborne Particulates and Precipitation

Early indications of possible fission product activity fluctuations in various phases of the environment are being secured through the continuous surveillance of gross beta activity in air and precipitation. The information obtained through this form of surveillance does not by itself permit evaluation of biological effects due to fallout, but it does form the basis for an alerting system and can be used as a guide for determining when and where more extensive monitoring of radioactivity in food, milk, and water is desirable.

In this section, gross beta concentrations for April 1963 are presented in reports from the Radiation Surveillance Network and the Canadian Radioactive Fallout Study Program. Network intercalibration factors, determined by Lockhart and Patterson (*1*), were used in constructing the isogram map (figure 4), which presents data on Canadian and U.S. gross beta radioactivity in air for April. To adjust the data from the two networks to a common baseline, the U.S. data were multiplied by a factor of 1.54, the U.S.-Canadian intercalibration factor suggested by the NRL study.

REFERENCE

(*1*) Lockhart, L. B., Jr., and R. L. Patterson, Jr.: *Intercalibration of Some Systems Employed in Monitoring Fission Products in the Atmosphere, NRL Report 5850,* Washington, D. C. (November 13, 1962); abstracted in *Radiological Health Data,* December 1962.

RADIATION SURVEILLANCE NETWORK April 1963

Division of Radiological Health, Public Health Service

The Radiation Surveillance Network (RSN) comprises 72 sampling stations distributed throughout the United States (see figure 1). Most of these stations are manned by State health department personnel.

Air

Daily 24-hour samples are collected on a 4-inch diameter, carbon-loaded cellulose dust filter in a high-volume air sampler. Field estimates of the gross beta activity of airborne particulates are derived by comparing portable survey meter readings of these filters with readings taken from a Sr^{90}–Y^{90} source of known activity. This determination is usually made about 5 hours after the end of collection to eliminate interference from naturally occurring radon daughters. The Network's station operators report their field estimates daily by telephone to the Radiation Surveillance Center, Division of Radiological Health, Washington, D.C. From this information, a daily national report is prepared.

The filters are then forwarded to the Radiation Surveillance Network laboratory in Rockville,

FIGURE 1.—RADIATION SURVEILLANCE NETWORK SAMPLING STATIONS, APRIL 1963

Maryland, for a more refined measurement with a thin-window, gas-flow proportional counter, calibrated with a 40,000-pc Sr^{90}–Y^{90} standard. Each filter is counted at least 3 days after the end of the sampling period and re-counted 7 days later. The initial 3-day aging of the sample eliminates interference from naturally occurring radon and thoron daughters. From the two counts, which are separated by a 7-day interval, it is possible to estimate the age of fission products and to extrapolate the activity to the time of collection. The extrapolation is performed by using the Way-Wigner formula: $AT^{1.2}$ = constant (*1*)*. The daily concentrations and estimated age are reported by the PHS in a monthly RSN report (*2*).

The average fission-product beta concentrations in surface air during April 1963, as determined by laboratory analysis and extrapolated to the time of collection, are given in table 1. These data (adjusted by the intercalibration factor, 1.54), together with corresponding Canadian data, are represented by isogram lines in figure 4 to show the distribution of fission product activity over most of North America.

* In this expression, A is the activity and T is the time after fission product formation.

Precipitation

Continuous sampling for total precipitation is conducted at most stations on a daily basis using funnels with collection areas of 0.4 square meters. A 500-ml aliquot of the collected precipitation is evaporated to dryness, and the residue is forwarded to the laboratory to be counted by the same method used for analyzing the air samples, including extrapolation to the time of collection. If the collected sample is between 200 and 500 ml, the entire sample is evaporated. When a sample is smaller than 200 ml. (equivalent to 0.5 mm or 0.02 inches of rainfall), the volume of precipitation is reported, but no analysis is made. April 1963 averages of gross beta activity in precipitation, expressed in picocuries per liter (pc/liter) and nanocuries per square meter (nc/m²), are presented in table 2.

Profiles

The profiles of the monthly average fission product beta activity in airborne particulates for each RSN station covering the period of time from the formation of the network in 1956 to the end of 1960 were published in *RHD*, July 1961. The profiles of 7 stations, updated through April 1963, are shown in figure 2.

TABLE 1.—FISSION PRODUCT GROSS BETA ACTIVITY IN SURFACE AIR, RSN, APRIL 1963

[Concentrations in pc/m³]

Station location		Number of samples	Maximum	Minimum	Average[1]
Alaska:	Adak	30	10	0.13	3.6
	Anchorage	30	8.5	0.37	3.7
	Attu	30	12	0.39	5.6
	Fairbanks	25	7.4	0.71	4.2
	Juneau	25	9.9	0.42	4.1
	Kodiak	27	13	0.22	3.9
	Nome	23	3.1	0.25	1.3
	Point Barrow	19	7.2	0.75	4.2
	St. Paul Island	25	7.9	0.25	4.2
Ariz:	Phoenix	29	30	5.7	13
Ark:	Little Rock	29	17	5.4	11
Calif:	Berkeley	28	7.7	0.65	3.9
	Los Angeles	21	14	3.5	6.7
Colo:	Denver	26	22	6.0	13
Conn:	Hartford	27	12	0.80	6.9
Del:	Dover	19	24	2.3	12
D.C:	Washington	30	14	1.5	7.6
Fla:	Jacksonville	29	17	1.9	9.3
	Miami	28	16	4.2	9.9
Ga:	Atlanta	26	13	1.4	8.0
Guam:	Agana	19	7.1	<0.10	2.5
Hawaii:	Honolulu	29	9.4	0.86	4.1
Idaho:	Boise	28	18	1.2	8.3
Ill:	Springfield	28	12	0.81	6.4
Ind:	Indianapolis	29	14	0.79	7.5
Iowa:	Iowa City	30	12	0.99	5.8
Kans:	Topeka	25	15	2.8	8.4
Ky:	Frankfort	30	16	1.5	8.1
La:	New Orleans	29	12	0.69	7.6
Maine:	Augusta	30	14	0.91	6.5
	Presque Isle	30	8.4	0.17	4.3
Md:	Baltimore	21	12	1.6	7.7
	Rockville	17	14	1.3	8.6
Mass:	Lawrence	29	11	<0.10	5.9
	Winchester	28	18	<0.10	9.4
Mich:	Lansing	28	17	0.97	7.9
Minn:	Minneapolis	29	11	0.65	6.0
Miss:	Jackson	30	14	2.2	8.7
	Pascagoula	21	16	3.2	10
Mo:	Jefferson City	29	17	1.3	7.5
Mont:	Helena	28	13	2.0	6.3
Nebr:	Lincoln	17	13	2.3	7.4
Nev:	Las Vegas	22	31	4.9	14
N.H:	Concord	21	15	0.14	7.9
N.J:	Trenton	30	16	0.81	7.8
N. Mex:	Santa Fe	27	19	3.3	9.9
N.Y:	Albany	28	11	0.43	6.2
	Buffalo	26	14	0.97	7.6
	New York	15	13	0.32	6.4
N.C:	Gastonia	29	15	4.8	8.8
N. Dak:	Bismarck	30	11	1.7	6.1
Ohio:	Cincinnati	20	12	0.92	7.2
	Columbus	29	18	1.1	8.6
	Painesville	30	14	1.1	8.8
Okla:	Oklahoma City	29	15	2.5	7.8
	Ponca City	30	9.8	2.1	5.5
Ore:	Portland	30	14	2.3	6.1
Pa:	Harrisburg	21	16	1.7	7.8
P.R:	San Juan	29	18	1.2	5.6
R.I:	Providence	28	15	0.29	7.2
S.C:	Columbia	29	15	3.1	7.5
S. Dak:	Pierre	30	14	1.1	5.8
Tenn:	Nashville	30	17	3.4	11
Tex:	Austin	30	21	1.3	8.6
	El Paso	30	23	4.5	12
Utah:	Salt Lake City	29	16	0.25	8.8
Vt:	Barre	30	17	0.18	6.7
Va:	Richmond	29	10	1.9	6.4
Wash:	Seattle	30	6.6	0.85	2.9
W.Va:	Charleston	27	14	1.5	7.3
Wis:	Madison	29	17	0.82	8.2
Wyo:	Cheyenne	30	22	2.6	10
Network average					7.3

[1] Averages are weighted by length of sampling time.

TABLE 2.—GROSS BETA ACTIVITY IN PRECIPITATION, RSN, APRIL 1963

Station location		Average concentration (pc/liter)	Total deposition[a] (nc/m²)
Alaska:	Anchorage	2,200	49
	Fairbanks	2,000	13
	Juneau		
Ariz:	Phoenix	[b]—	[b]—
Ark:	Little Rock	970	87
Calif:	Berkeley	770	100
	Los Angeles	1,900	91
Colo:	Denver	[b]—	[b]—
Conn:	Hartford	3,200	49
D.C:	Washington	7,900	180
Fla:	Jacksonville	2,000	29
	Miami	[b]—	[b]—
Ga:	Atlanta	640	20
Hawaii:	Honolulu	[b]—	[b]—
Idaho:	Boise	4,000	270
Ill:	Springfield	2,000	20
Ind:	Indianapolis	1,900	170
Iowa:	Iowa City	3,700	230
Kans:	Topeka	4,300	72
Ky:	Frankfort	1,700	61
La:	New Orleans	2,500	69
Maine:	Augusta	2,300	120
	Presque Isle	2,000	66
Md:	Baltimore	2,900	84
Mass:	Lawrence	1,900	40
	Winchester	3,500	78
Mich:	Lansing	4,400	180
Minn:	Minneapolis	2,300	130
Miss:	Jackson	3,500	35
Mo:	Jefferson City	2,200	93
Mont:	Helena	3,300	104
Nebr:	Lincoln	8,000	57
Nev:	Las Vegas	[b]—	[b]—
N.J:	Trenton	3,300	10
N. Mex:	Santa Fe	3,700	28
N.Y:	Albany	[c]	[c]
	Buffalo	[b]—	[b]—
N.C:	Gastonia	900	64
N. Dak:	Bismarck	4,300	200
Ohio:	Columbus	3,000	330
	Painesville	3,400	200
Okla:	Oklahoma City	1,300	43
	Ponca City	1,300	22
Ore:	Portland	1,200	92
Pa:	Harrisburg	4,300	47
P.R:	San Juan	670	34
R.I:	Providence	4,500	93
S.C:	Columbia	1,700	150
S. Dak:	Pierre	2,100	83
Tenn:	Nashville	1,900	110
Tex:	Austin	1,500	79
	El Paso	[b]—	[b]—
Utah:	Salt Lake City	3,600	390
Vt:	Barre	2,700	170
Va:	Richmond	3,400	29
Wash	Seattle	2,900	130
W.Va:	Charleston	4,800	94
Wisc:	Madison	3,200	130
Wyo:	Cheyenne	6,000	170

[a] Precipitation (mm) = $\frac{nc/m^2}{pc/liter} \times 1{,}000$.

[b] Dash indicates no evaporated sample received.

[c] No data received.

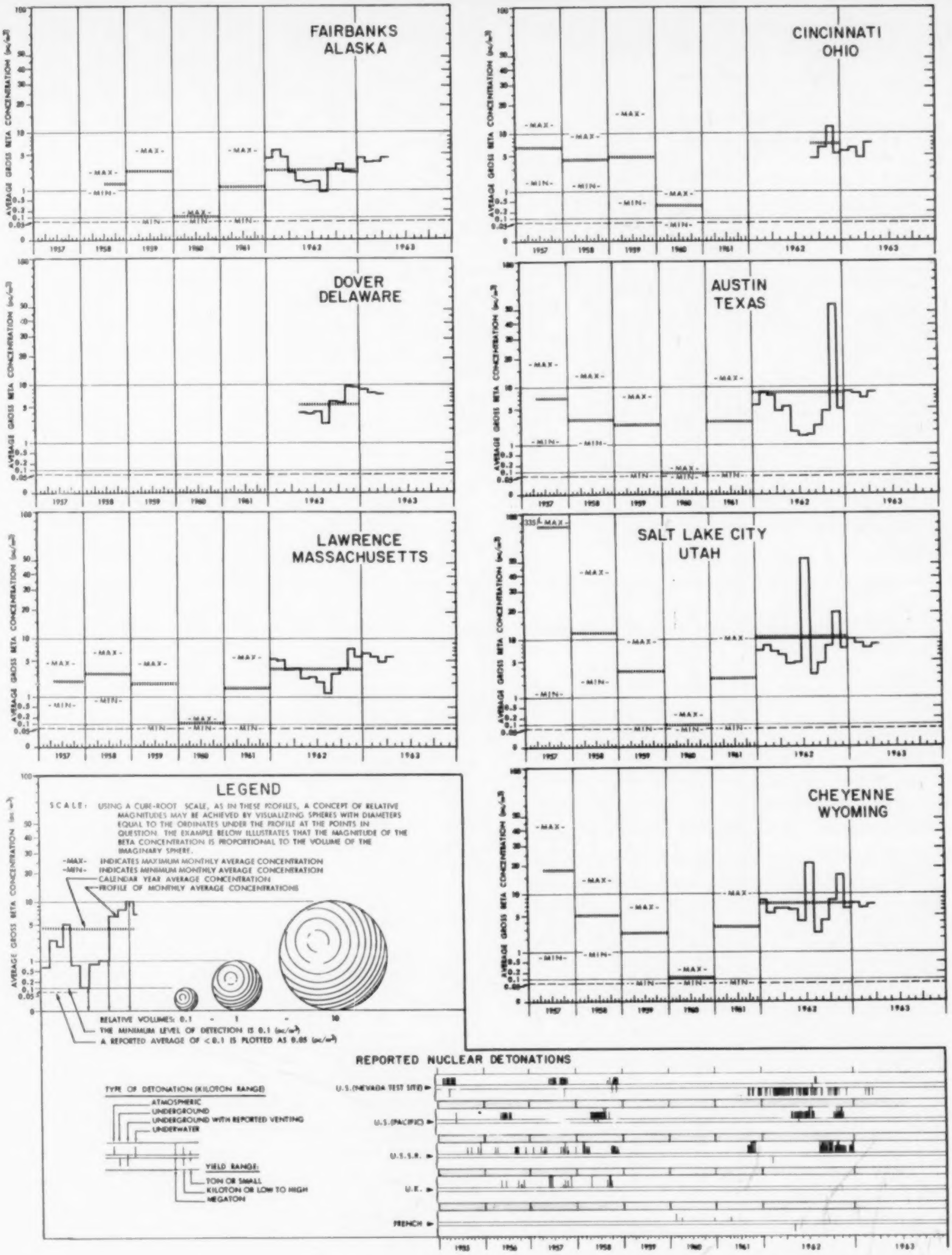

Figure 2.—MONTHLY AND YEARLY PROFILES OF BETA ACTIVITY IN AIR, RADIATION SURVEILLANCE NETWORK, 1957-APRIL 1963

REFERENCES

(*1*) Way, K., and E. P. Wigner: The Rate of Decay of Fission Products, *Physics Review*, *73*:1318–30 (June 1948).

(*2*) Radiation Surveillance Network: *Monthly Tabulation of Findings*, Division of Radiological Health, Public Health Service. Washington 25, D. C. (Distribution by official request).

[1] See reference (*1*) on page 1–1.

CANADIAN RADIOACTIVE FALLOUT STUDY PROGRAM
April 1963

Department of National Health and Welfare, Ottawa, Canada

As part of its Radioactive Fallout Study Program (RFSP), the Radiation Protection Division of the Canadian Department of National Health and Welfare monitors air and precipitation. Twenty-four RFSP collection stations are located at airports (see figure 3) where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

Air

Each air sample involves the collection of particulates from about 650 cubic meters of air drawn through a high-efficiency 4-inch-diameter filter during a 24-hour period. These filters are sent daily to the Radiation Protection Division Laboratory in Ottawa. At the laboratory, a 2-inch-diameter disk is cut from each filter and counted with a thin-end-window, gas flow, Geiger-Mueller flow counter system, calibrated with a Sr^{90}–Y^{90} standard. Four successive measurements are

TABLE 3.—FISSION PRODUCT GROSS BETA ACTIVITY IN AIR, RFSP, APRIL 1963

[Concentrations in pc/m³]

Station	Number of samples	Maximum	Minimum	Average
Calgary	30	31.0	3.6	13.8
Coral Harbour	30	18.3	3.6	8.9
Edmonton	30	27.0	3.9	11.8
Ft. Churchill	29	11.1	2.5	7.3
Ft. William	30	25.0	1.0	10.6
Fredericton	30	25.0	0.7	9.2
Goose Bay	29	22.5	1.5	9.5
Inuvik	30	23.5	4.7	8.7
Montreal	30	26.5	0.7	12.8
Moosonee	30	23.0	1.5	11.0
Ottawa	30	22.0	2.9	12.6
Quebec City	30	29.0	0.6	10.8
Regina	30	20.0	3.2	12.4
Resolute	30	17.9	5.0	9.6
Saskatoon	28	26.5	4.1	14.3
Sault St. Marie	30	20.6	1.9	12.1
Shearwater	30	25.0	0.3	8.9
Torbay	28	16.8	0.2	5.0
Toronto	30	26.5	2.0	11.5
Vancouver	30	19.8	1.7	7.3
Whitehorse	30	16.8	0.7	9.3
Windsor	30	25.0	2.4	14.0
Winnipeg	30	28.0	0.9	11.7
Yellowknife	30	15.5	3.8	9.5
Average				10.5

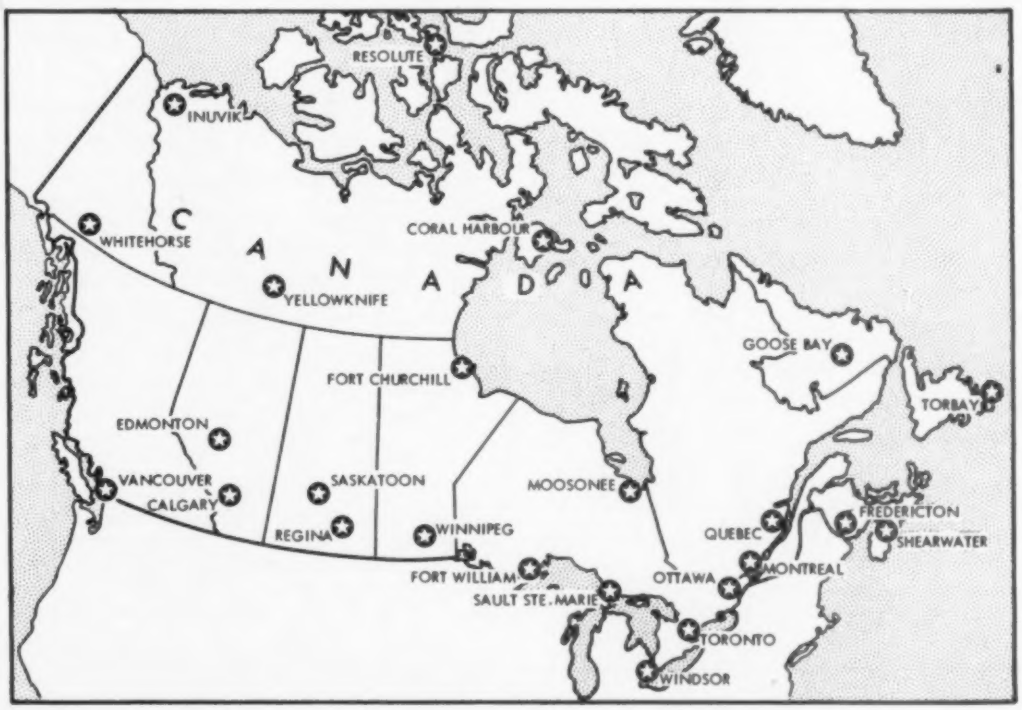

FIGURE 3.—CANADIAN AIR AND PRECIPITATION SAMPLING STATIONS, APRIL 1963

made on each filter to permit correction for the presence of natural activities and for the decay of short-lived fission products. The results are extrapolated to the end of the sampling period. Canadian air data for April 1963 are given in table 3 and presented in conjunction with U.S. adjusted air data by the isogram map (figure 4).

Precipitation

The amount of radioactive fallout deposited on the ground is determined from measurements on material collected in special polythene-lined rainfall pots. After transfer of the water to the sampling container, the polythene liner is removed, packed with the sample, and sent to the laboratory. April precipitation data for Canada, including some radiochemical analyses, are shown in table 4.

REFERENCES

(*1*) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1959 on the Radioactive Fallout Study Program, CNHW–RP–3*, Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) Bird, P. M., A. H. Booth, and P. G. Mar: *Annual Report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4*, Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*3*) Mar, P. G.: *Annual Report for 1961 on the Radioactive Fallout Study Program CNHW–RP–5*, Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) Beale, J. and J. Gordon: *The Operation of the Radiation Protection Division Air Monitoring Program, RPD–11*, Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) Booth, A. H.: *The Calculation of Maximum Permissible Levels of Fallout in Air and Water and Their Use in Assessing the Significance of 1961 Levels in Canada, RPD–21*, Department of National Health and Welfare, Ottawa, Canada (August 1962).

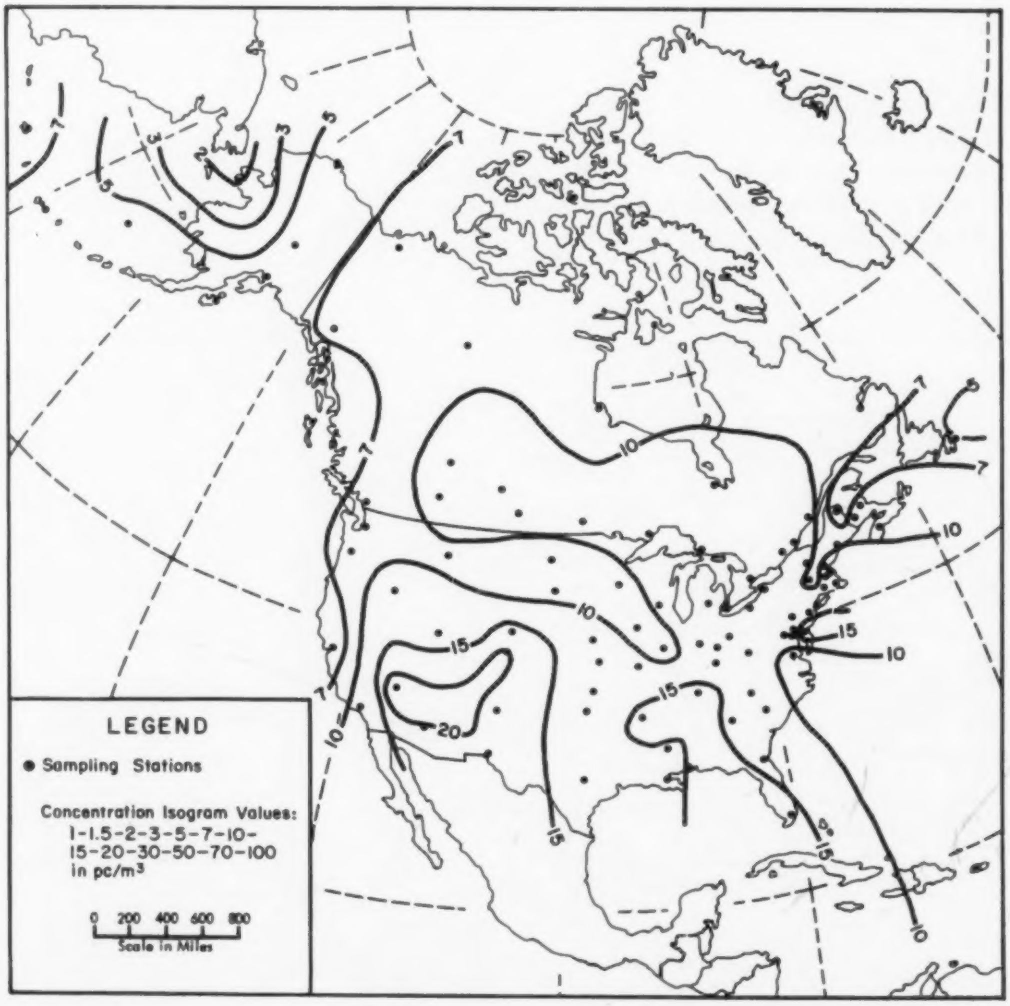

FIGURE 4.—AIRBORNE GROSS BETA CONCENTRATION ISOGRAM VALUES FOR CANADA AND THE U.S., APRIL 1963

TABLE 4.—FISSION PRODUCT GROSS BETA ACTIVITY IN PRECIPITATION, RFSP, APRIL 1963

Station	Total beta activity		Deposition of specific radionuclides for selected samples[a] (nc/m²)				
	pc/liter	nc/m²	Sr^{89}	[b]Sr^{90}	[b]Zr^{95}	[b]Cs^{137}	Ba^{140}
Calgary	6831	130.0	9.7	1.10	17.3	1.93	0.15
Coral Harbour	5513	47.6					
Edmonton	4240	88.2					
Fredericton	3007	205.2					
Ft. Churchill	2900	30.2					
Ft. William	4215	271.7					
Goose Bay	2597	80.4					
Inuvik	1858	28.3					
Montreal	4093	346.8	24.2	2.98	45.7	5.43	0.37
Moosonee	4457	162.9					
Ottawa	3430	233.1					
Quebec	3567	238.1					
Regina	6011	106.8					
Resolute	2679	68.0					
Saskatoon	4911	152.0					
Sault Ste. Marie	3565	123.9					
Shearwater	2122	232.1	18.0	1.98	24.8	4.36	0.24
Torbay	1455	219.7					
Toronto	4452	241.8					
Vancouver	3476	252.2	19.6	2.54	31.5	4.09	0.29
Whitehorse	[c]	42.3					
Windsor	3224	269.2					
Winnipeg	3269	295.3	20.9	2.84	45.5	5.20	0.31
Yellowknife	8895	56.5					
Average	3946	136.4					

[a] All values corrected for decay back to end of collection month.
[b] Values for strontium-90, cesium-137, and zirconium-95 do not include the activities of their daughter isotopes, yttrium-90, barium-137, and niobium-95.
[c] Trace precipitation.

Fission Product Gamma Activity in Airborne Particulates

In a recent proposal (*1*) submitted by the World Meteorological Organization (WMO), after consultation with the United Nations Scientific Committee on the Effects of Atomic Radiation, the concept of air monitoring for fission products by gamma rather than beta counting was advanced. The method involving the simultaneous measurement of total gamma and of gamma-over-1-Mev has been adopted for use with the 80th Meridian Network (*2*).

REFERENCES

(*1*) United Nations General Assembly, Seventeenth Session: *Agenda Item 30, Report of the United Nations Scientific Committee on the Effects of Atomic Radiation—Report of the World Meteorological Organization on the Implementation of General Assembly Resolution 1629* (XVI), New York, October 8, 1962.

(*2*) Collins, W. R., Jr.: Fission Product Gamma Activity in Airborne Particulates, The 80th Meridian Network, January 1963, *Radiological Health Data*, *4*:342–6, Superintendent of Documents, Government Printing Office, Washington 25, D. C. (July 1963).

THE 80TH MERIDIAN NETWORK February 1963

Health and Safety Laboratory
Atomic Energy Commission

This report covers the data available for gamma activity measurements performed on ground-level air filter samples from the 80th Meridian Network for February 1963. Sampling locations of the Network are shown in figure 1. Through the end of February, all stations operated as previously described by the Naval Research Laboratory,[1]

[1] Monthly gross beta averages and profiles of the 80th Meridian Network, Naval Research Laboratory, covering the period from November 1959 through December 1962, were reported monthly in *Radiological Health Data*—April 1960–April 1963. Results of the radiochemical analyses of air filters for the calendar years 1960 and 1961 were presented in *RHD*—March 1962 and February 1963, respectively.

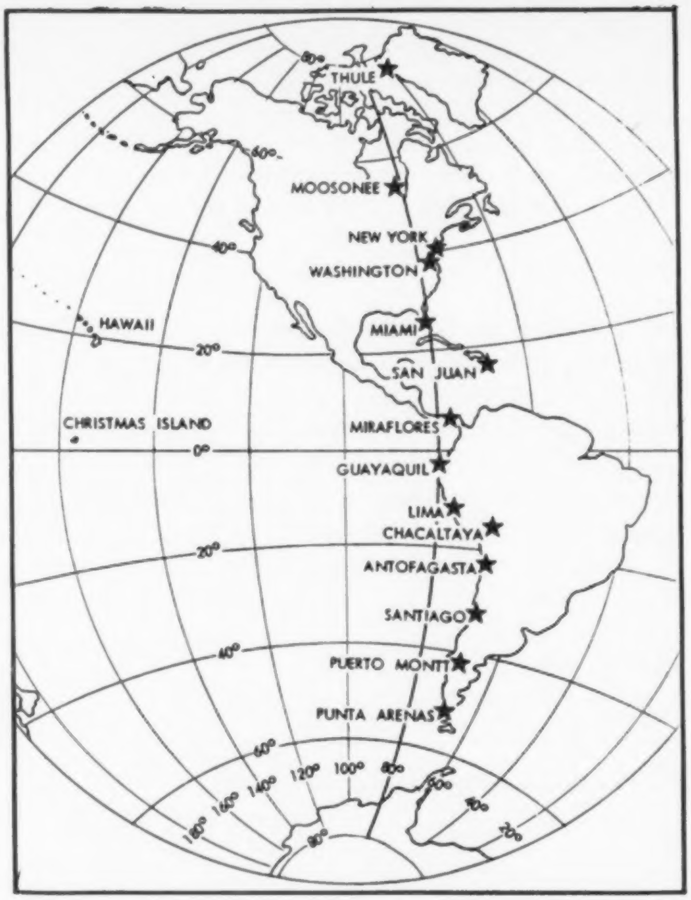

FIGURE 1—ATMOSPHERIC RADIOACTIVITY SAMPLING STATIONS NEAR THE 80TH MERIDIAN (WEST)

sampling about 1200 cubic meters of air per day on 8-inch cellulose asbestos (type 6) filter papers. Samples were changed, when possible, on the 1st, 8th, 15th, and 22nd of the month and forwarded to the Health and Safety Laboratory for gamma radiometric and radiochemical analyses.

Each sample received was counted approximately two weeks after the midpoint of the sampling period on an 8 x 4 inch sodium iodide (thallium) crystal, obtaining both total gamma activity and the fraction of the gamma activity with energies above 1.0 Mev. The results, in terms of gamma photons per minute per cubic meter, are listed in table 1. The monthly averages are illustrated in figure 2 as an activity-latitude profile. Total beta activity estimates, obtained by the method described in the January 1963 report[2] are also listed in table 1.

The ratio of hard gamma (over 1 Mev) to total gamma gives some indication of age of fission products. Based on a sample of irradiated U^{235}, fission products having an average age greater than four months show a fairly constant gamma ratio of 0.011, and younger fission products show a higher ratio.[2] The gamma ratios shown in table 1 show little difference between Northern and Southern Hemispheres.

TABLE 1.—ACTIVITY OF SURFACE AIR, 80TH MERIDIAN NETWORK, FEBRUARY 1963

Sampling station	Sampling period (dates—noon to noon)	Total/gamma activity (photons/min/m³)		Ratio: $\frac{\gamma > 1 \text{ Mev}}{\text{Total } \gamma}$	Estimated total beta activity (pc/m³)
		Filter	Average for month		
Thule	2/1-8	6.69		0.020	4.5
	2/8-15	8.49		0.020	5.7
	2/15-22	12.5		0.020	8.5
	2/22-3/1	14.2	10.5	0.017	9.6
Moosonee	2/1-8	8.47		0.030	5.7
	2/22-3/1	8.29	8.41	0.021	5.6
New York [a]	—	—	—	—	—
Washington	2/1-8	15.7		0.026	10.6
	2/8-15	7.66		0.019	5.2
	2/15-22	11.0		0.028	7.4
	2/22-3/1	11.8	11.5	0.016	8.0
Miami	2/1-8	19.5		0.020	13.1
	2/8-15	12.0		0.022	8.1
	2/15-22	18.4		0.022	12.4
	2/22-3/1	14.9	15.9	0.022	10.1
Mauna Loa	2/1-8	4.60		0.023	3.1
	2/8-15	2.50		0.024	1.7
	2/15-22	6.35		0.024	4.3
	2/22-3/1	6.44	4.97	0.023	4.3
San Juan	2/1-8	4.55		0.022	3.1
	2/8-15	5.98		0.023	4.0
	2/15-22	6.86		0.023	4.6
	2/22-3/1	4.66	5.48	0.022	3.1
Miraflores	2/1-8	4.63		0.024	3.1
	2/8-15	3.55		0.025	2.4
	2/15-22	4.18		0.024	2.8
	2/22-3/1	5.66	4.52	0.029	3.8
Guayaquil [b]	—	—	—	—	—
Lima [b]	—	—	—	—	—
Chacaltaya	2/1-8	0.985		0.014	0.67
Antofagasta	2/1-8	0.578		0.019	0.39
	2/8-15	0.715		0.013	0.48
	2/15-22	0.569		0.019	0.38
	2/22-3/1	0.340	0.551	0.022	0.23
Santiago	2/1-8	0.392		0.020	0.26
	2/8-15	0.438		0.018	0.30
	2/15-22	0.501		0.014	0.34
	2/22-3/1	0.358	0.422	0.027	0.24
Puerto Montt	2/1-8	0.261		0.012	0.18
	2/8-15	0.145		0.023	0.10
	2/15-22	0.285		0.015	0.19
	2/22-3/1	0.118	0.204	0.020	0.08
Punta Arenas	2/1-8	0.306		0.011	0.21
	2/8-15	0.216		0.023	0.15
	2/15-22	0.172	0.239	0.021	0.12

[a] Scheduled to begin operation in March 1963.
[b] Data not available.

In general, the total activity estimates show little variation in either the Northern or Southern Hemispheres from the January 1963 estimates or values previously reported by the Naval Research Laboratory during the last quarter of 1962; the surface air activity in the Southern Hemisphere continues to be less than a tenth that of the Northern Hemisphere.

[2] See reference (2) above.

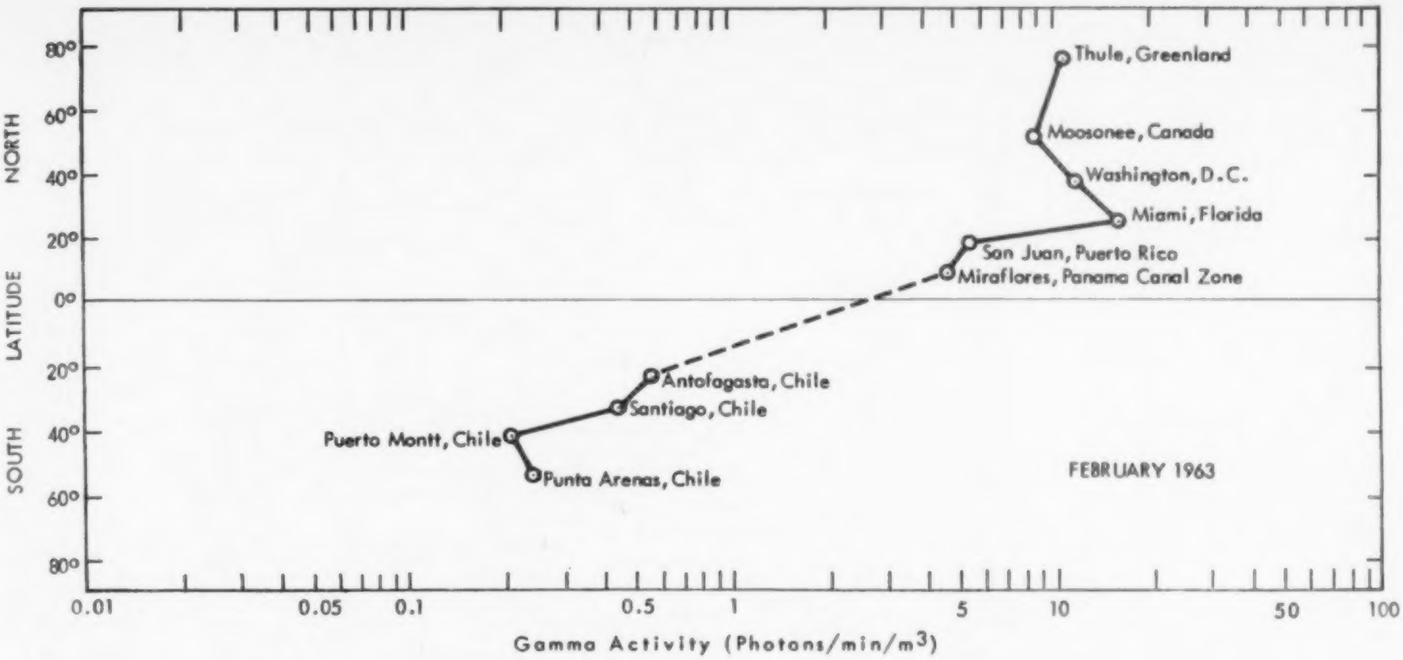

FIGURE 2.—PROFILE OF SURFACE AIR GAMMA ACTIVITY, FEBRUARY, 1963

Monthly Deposition of Various Radionuclides

For the purposes of this section, fallout is defined as any radioactive material deposited on the earth's surface. Fallout is composed of two fractions: that deposited by the settling of particulates, often termed dry fallout; and that contained in precipitation, sometimes called wet fallout or rainout. Normally, fallout is expressed in terms of the activity of selected radionuclides deposited on a unit surface area during a given period of time.

FALLOUT IN THE UNITED STATES AND OTHER AREAS*
January 1962–June 1962

Health and Safety Laboratory
Atomic Energy Commission

Monthly fallout deposition rates are determined by the Atomic Energy Commission's Health and Safety Laboratory (HASL) for 40 sites in the United States and 93 locations in other countries. HASL data from 37 of the U.S. stations and 8 other selected points in the Western Hemisphere (see figure 1) covering the period from January 1961 through June 1962 are summarized below.

* The data in this article were extracted from *Fallout Program Quarterly Summary Report, HASL–135*:2–144 (April 1, 1963).

Methods of Collection

Two methods of fallout collection are employed by HASL. In the first, precipitation and dry fallout for a period of one month are collected in stainless steel pots with exposed areas of $0.076m^2$. At the end of the collection period, the contents are transferred, by careful scrubbing with a rubber spatula to a polyethylene sample bottle which is then shipped to the laboratory for analysis.

The second method involves the use of a polyethylene funnel, with exposed area of $0.072m^2$, attached to an ion-exchange column. After a one-month collection, the inside of the funnel is wiped with a tissue, and the tissue is inserted in the end of the column, which is then sealed and sent to HASL for analysis.

A statistical analysis comparing results obtained using the two types of collectors has been published (*1*). This study was based on strontium–90 measurements of duplicate samples from five locations in the United States where both pot and column samples were collected. It was found that at the 95 percent confidence level there was no significant difference in the strontium–90 measurements obtained from pot and column samples.

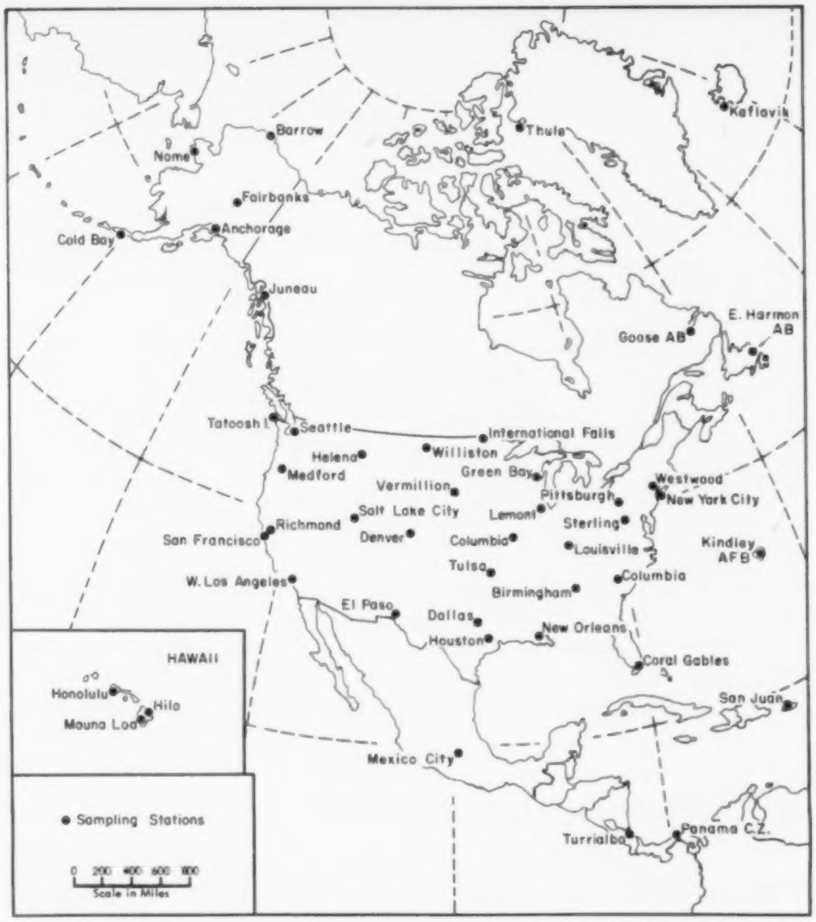

FIGURE 1—HASL FALLOUT SAMPLING LOCATIONS

Strontium–90

All of the HASL fallout samples—both pot and column—were assayed for strontium–90 and the ratio of strontium–89 to strontium–90. The strontium–90 data are given in table 1 for the 48 selected stations. Where duplicate samples were collected, the average values are given.

TABLE 1.—MONTHLY STRONTIUM–90 FALLOUT
[Deposition in nc/m²]

Sampling location and type of collection		1962					
		January	February	March	April	May	June
Ala:	Birmingham (pot)	1.74	1.11	1.44	3.20	0.66	0.70
Alaska:	Anchorage (col)	0.10	0.25	0.22	0.35	0.33	0.88
	Barrow (col)	<0.01	<0.01	<0.01	0.01	0.77	0.46
	Cold Bay (col)	[a]—	—	—	0.26	1.52	1.00
	Fairbanks (col)	0.08	0.22	0.18	0.08	0.22	0.99
	Juneau (col)	0.40	0.06	0.51	0.05	0.52	1.39
	Nome (col)	0.42	—	0.47	0.47	0.14	0.26
Calif:	W. Los Angeles (pot)	0.46	3.29	0.53	0.07	0.07	0.05
	Richmond (pot)	0.32	1.64	0.27	0.29	0.02	0.04
	Richmond (col)	0.27	1.24	0.86	0.27	0.02	0.05
	San Francisco (col)	0.29	1.34	0.43	0.21	0.05	0.03
Colo:	Denver (col)	0.06	—	0.14	0.98	0.78	1.37
Fla:	Coral Gables (pot)	0.24	0.24	0.62	1.35	0.37	0.80
Hawaii:	Hilo (col)	0.31	1.43	2.20	0.32	3.38	0.84
	Mauna Loa (col)	0.16	0.02	0.41	0.41	0.57	0.07
	Oahu (pot)	0.36	1.07	1.37	0.22	0.98	0.56
Ill:	Lemont (pot)	0.60	0.57	0.02	0.63	2.69	0.64
Ky:	Louisville (pot)	0.79	0.92	1.16	0.51	1.52	1.55
La:	New Orleans (col)	0.64	0.24	0.58	1.11	0.47	0.91
Minn:	International Falls (col)	0.07	0.15	0.28	0.05	3.46	2.06
Mo:	Columbia (col)	2.62	0.88	1.10	1.07	2.25	0.69

TABLE 1.—MONTHLY STRONTIUM-90 FALLOUT—Continued

[Deposition in nc/m²]

Sampling location and type of collection			1962					
			January	February	March	April	May	June
Mont:	Helena	(col)	0.04	0.14	0.16	0.06	1.66	1.53
N.J.:	Westwood	(pot)	0.57	1.18	0.81	2.12	1.02	1.85
	Westwood	(col)	0.53	1.11	0.72	1.89	1.15	2.09
N.Y:	New York	(pot)	0.36	1.22	0.56	0.85	0.88	1.49
N. Dak:	Williston	(col)	0.03	0.09	0.18	0.28	1.89	1.11
Okla:	Tulsa	(pot)	1.35	0.78				
Ore:	Medford	(col)	0.19	0.18	0.39	0.29	0.56	0.12
Pa:	Pittsburgh	(pot)	0.51	0.80	0.87	1.49	1.36	0.60
	Pittsburgh	(col)	0.56	0.80	0.92	1.65	1.55	0.67
S.C:	Columbia	(col)	0.72	0.83	1.57	0.09	1.51	0.87
S. Dak:	Vermillion	(pot)	0.06	0.48	1.27	1.95	6.00	1.56
Tex:	Dallas	(col)	0.32	0.40	0.98	2.87	0.36	1.38
	El Paso	(col)	0.39	0.15	0.11	0.27	0.03	—
	Houston	(pot)	0.31	0.26	0.40	1.86	0.17	1.59
	Houston	(col)	0.37	0.19	0.33	1.56	0.16	0.82
Va:	Sterling	(col)	0.33	0.54	0.62	1.05	0.93	0.95
Utah:	Salt Lake City	(pot)	0.45	1.74	2.15	2.61	4.12	0.13
Wash:	Seattle	(pot)	0.59	0.60	1.62	0.91	1.02	0.34
	Tatoosh I.	(col)	0.82	0.67	1.35	1.71	0.76	0.34
Wis:	Green Bay	(col)	0.10	0.66	0.72	1.01	0.21	1.82
Greenland:	Thule	(col)	<0.01	<0.01	<0.01	0.04	0.05	<0.01
Iceland:	Keflavik	(col)	0.60	0.20	0.27	0.91	0.55	0.67
Newfoundland:	Goose A.B.	(col)	0.05	0.14	0.29	0.02	0.96	1.09
	E. Harmon A.B.	(col)	0.33	0.23	0.17	0.83	0.94	1.48
Bermuda:	Kindley A.F.B.	(col)	0.40	0.42	2.71	1.07	0.84	0.43
Puerto Rico:	San Juan	(col)	0.59	0.39	—	1.37	1.01	0.61
Mexico:	Mexico City	(col)	<0.01	0.01	<0.01	1.05	0.23	0.31
Costa Rica:	Turrialba	(col)	0.32	0.15	0.16	0.47	0.44	0.14
Panama Canal Zone		(col)	0.16	<0.01	0.04	—	—	0.73

TABLE 2.—RADIOCHEMICAL ANALYSES OF POT FALLOUT SAMPLES

Location and analyses	1962					
	January	February	March	April	May	June
California, Richmond						
Precipitation (mm)	30	226	22	8	dry	dry
Sr^{89}/Sr^{90} ratio	38	26	21	10	7.6	4.6
Zr^{95} (nc/m²)	[a]—	20.1	10.8	—	0.01	0.93
Cs^{137} (nc/m²)	0.46	2.2	0.50	0.50	0.04	0.01
Ba^{140} (nc/m²)	2.83	[b]ND	—	—	—	—
New Jersey, Westwood						
Precipitation (mm)	75	113	116	86	32	160
Sr^{89}/Sr^{90} ratio	46	30	18	12	10	5.4
Zr^{95} (nc/m²)	41	51	19	32	15	22
Cs^{137} (nc/m²)	1.05	1.83	1.19	3.20	1.46	3.25
Ba^{140} (nc/m²)	3.9	2.40	—	—	—	—
Pennsylvania, Pittsburgh						
Precipitation (mm)	52	90	77	116	66	41
Sr^{89}/Sr^{90} ratio	48	28	20	14	9.6	6.4
Zr^{95} (nc/m²)	22.3	20.2	22.4	32.2	27.0	3.8
Cs^{137} (nc/m²)	—	—	1.88	3.76	2.68	1.08
Ba^{140} (nc/m²)	3.8	1.4	—	—	—	—
Texas, Houston						
Precipitation (mm)	32	15	15	122	29	188
Sr^{89}/Sr^{90} ratio	58	26	18	13	20	8.6
Zr^{95} (nc/m²)	8.1	6.6	31	51	11	80
Cs^{137} (nc/m²)	—	—	—	—	—	—
Ba^{140} (nc/m²)	8.2	1.1	1.1	—	—	—

[a] Dash indicates sample not analyzed.
[b] Not detected.

Other Radionuclides

Laboratories at Richmond, California; Westwood, New Jersey; Pittsburgh, Pennsylvania; and Houston, Texas, have analyzed duplicate monthly collections for various radionuclides. The monthly deposition rates for Zr^{95}, Cs^{137}, and Ba^{140}, as well as the Sr^{89}/Sr^{90} ratio and precipitation depth, are presented in table 2. The strontium-90 values for these stations are included in table 1.

REFERENCE

(*1*) Ong, L. D. Y., Homogeneity Between Pot and Ion Exchange Columns Strontium-90 Measurements, *Fallout Program Quarterly Summary Report, HASL 135*:256–69, Office of Technical Services, Department of Commerce, Washington 25, D. C. (April 1, 1963), price $4.00.

SECTION II.—FOOD

Strontium-90 and Calcium in Infant and Adult Diets[1]

1959–1962

Joseph Rivera[2]

Since the rate of bone formation is high during the first year of life, it is particularly important to know the dietary intake of strontium-90 during this period so that reasonable estimates can be made of body burdens of strontium-90 in young children. The dietary estimates of strontium-90 intake are complicated since the foods eaten at this age are especially processed and may not have the same strontium-90 concentrations as the same type foods prepared for adult consumption.

Previous studies on this problem at the Health and Safety Laboratory suggested that a good indication of the strontium-90 and calcium content of infant diets could be made by analyzing only formula and evaporated milks prepared especially for infant use (*1*). With this in mind, formula and evaporated milks were added to the purchasing lists used in the tri-city diet surveys (*2*) at New York City, Chicago, and San Francisco. Results of the analyses of samples obtained from April 1962 to November 1962 are presented in table 1.

From these data, estimates of the Sr^{90}/Ca ratio in the total diet of 0-1-year-old infants were made. Since formula and evaporated milks provide about 89 percent of the strontium-90 intake and about 81 percent of the calcium intake during the first year of life (*1*), the Sr^{90}/Ca ratio in the infant total diet can be estimated by computing the Sr^{90}/Ca ratio of the milk component of the diet and multiplying this by 0.91. The Sr^{90}/Ca ratio of the milk component of the diet was calculated by summing the yearly strontium-90 contribution from formula and evaporated milks (assuming that 55 g Ca per year were taken in via formula milk consumption and 301 g Ca per year were taken via evaporated milk consumption) and dividing by the yearly calcium intake (356 g Ca/year) from these sources (*1*).

Estimates of the Sr^{90}/Ca ratio of the diet during the first year of life, along with previous data on infant diets (where diet components other than formula and evaporated milk were measured), are shown in table 2. Also shown are adult diet results obtained from the tri-city diet survey (*2*).

It is fairly apparent that the Sr^{90}/Ca ratios in infant diets have been essentially the same as those in adult diets despite the difference between the composition of the diets.

In a recent survey of consumption of whole fresh milk in the United States, it was found that only 30 percent of infants in the 0-1-year-old bracket consumed at least one quart of milk per day (*3*). The implication of this finding is that 70 percent of infants in this age range were drinking some formula and evaporated milks or were being

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[1] Originally published in *Fallout Quarterly Summary Report, HASL-135* (April 1, 1963).

[2] Mr. Rivera is a physicist on the staff of Environmental Studies Division of the Health and Safety Laboratory, U. S. Atomic Energy Commission.

TABLE 1.—RADIONUCLIDES IN CONSTITUENTS OF INFANT DIETS

Location	Month (1962)	Formula milk		Evaporated milk		Fresh liquid milk	
		pc Sr^{90}/g Ca	Sr^{89}/Sr^{90}	pc Sr^{90}/g Ca	Sr^{89}/Sr^{90}	pc Sr^{90}/g Ca	Sr^{89}/Sr^{90}
New York City	Aug.	17.0	2.1	8.1	[a]ND	16.2	6
	Nov.	12.7	0.8	18.7	1.2	13.6	2.6
Chicago	April	7.3	1.9	5.1	1.1	4.8	1.3
	July	15.4	2.5	20.5	2.1	11.5	3.3
	Oct.	11.8	1.7	18.4	2.3	8.5	5.8
San Francisco	May	6.5	0.5	2.6	6	5.3	12
	June	6.1	5.6	[b]—	[b]—	2.4	5
	Sept.	20.7	2.1	3.8	1.2	3.1	2.3

[a] Not determinable.
[b] Sample lost.

TABLE 2.—ESTIMATED PICOCURIES OF STRONTIUM-90 PER GRAM CALCIUM IN INFANT AND ADULT DIETS

Location and date	Total diet		Fresh Liquid milk
	Infant 0–1 yr.	Adult	
New York			
Aug. 59	14	18	11
Aug. 60	7	11	9
Aug. 61	6	9	5
Aug. 62	[a]9	14	16
Nov. 62	[a]17	17	14
Chicago			
Aug. 61	5	6	[b]4
April 62	[a]5	8	5
July 62	[a]18	13	12
Oct. 62	[a]16	14	9
San Francisco			
Aug. 61	3	3	[b]5
May 62	[a]3	5	5
June 62	[c]—	5	2
Sept. 62	[a]6	6	3

[a] Calculated from formula and evaporated milk strontium-90 concentration.
[b] Data from PHS Pasteurized Milk Network.
[c] No sample.

breast fed. Thus the diet estimates presented here, based on the consumption of these processed milks, are probably valid for at least half of the infants residing in the metropolitan areas of the three cities.

REFERENCES

(*1*) U. S. Atomic Energy Commission: *Fallout Program Quarterly Summary Report, HASL–122:*185–7, Office of Technical Services, Department of Commerce, Washington 25, D. C. (April 1, 1962), price $3.00.

(*2*) Rivera, J.: Tri-City Diet Study, August–September 1962, *Radiological Health Data, 4:*289–90, Superintendent of Documents, Government Printing Office, Washington 25, D. C. (June 1963).

(*3*) Bureau of the Census, Department of Commerce and Division of Radiological Health, Public Health Service: National Food Consumption Survey—Fresh Whole Milk Consumption in the United States, July 1962, *Radiological Health Data, 4:*15–17 (January 1963).

SECTION III.—MILK

Milk Surveillance

Although milk is only one of the many sources of dietary intake of radionuclides, it is the single food item most often used as an indicator of the population's intake of radionuclides from the environment. This is because fresh milk is consumed by a large segment of the U.S. population and contains most of the radionuclides identified as being biologically important. In addition, milk is produced and consumed on a regular basis, is convenient to handle, is easily analyzed, and samples which are representative of milk consumption in any area can be readily obtained.

PASTEURIZED MILK NETWORK
April 1963

Division of Radiological Health and Division of Environmental Engineering and Food Protection, Public Health Service

The Public Health Service pasteurized milk radionuclide surveillance program had its origin in a 12-station raw milk monitoring network, which was established by the Service in 1957. One of the primary objectives of this network was the development of methods for milk collection and radiochemical analysis suitable for larger scale programs.

Experience derived from this earlier network led to the activation of a 46-station pasteurized milk sampling program in July 1960. The 46 stations were selected to provide general nationwide coverage of milk production and consumption areas.

As further needs developed, more milk sampling points were added, through July 1962, when the total number of stations reached was 62. Through the cooperation of State and local milk sanitation authorities, samples are routinely collected at each of these stations. After collection, the composites are preserved with formaldehyde and are sent to the PHS Southwestern, Southeastern, and Northeastern Radiological Health laboratories for analyses. Approximately 3–6 days after sample collection, any results from the gamma analyses for iodine–131 which indicate concentrations of this radionuclide greather than 100 pc/liter are made available to State public health officials and the Federal Radiation Council for possible public health action. Complete analytical results are available 6 to 7 weeks after sample collection; publication in *Radiological Health Data* follows 3 to 4 months after sample collection.

Sampling and Compositing Procedures

The method of compositing specifies that each station's sample be composited of subsamples from each milk processing plant in proportion to the plant's sales in the community served. At most stations, the composited sample represents from 80 to 100 percent of the milk processed. Prior to September 15, 1961, the composite sample was taken from one day's sales per month and was as representative of the community's supply as could be achieved under practical conditions. Beginning with the resumption of nuclear weapons testing in the atmosphere in September 1961 and

continuing at most stations through January 1963, sampling was done twice a week or daily for short periods at selected stations. Since then, sampling at most stations has been reduced to once a week.

All surveillance data are subject to continuing review and evaluation to observe unusual patterns or concentrations which may require immediate attention. Further atmospheric nuclear testing may require re-evaluation and adjustment of the sampling frequency and schedule of analyses for this program.

Analytical Errors in Radionuclide Measurements

Iodine–131, cesium–137, and barium–140 concentrations are determined by gamma scintillation spectroscopy,[1] while strontium–89 and strontium–90 concentrations are determined by radiochemical procedures. There is an inherent statistical variation associated with all measurements of radionuclide concentrations. With the low radionuclide levels which are usually found in milk and other environmental samples, this variation is relatively high. The variation is dependent upon the method of chemical analysis, the sample counting rate and counting time, interferences from other radionuclides and the background count. For milk samples, counting times of 50 minutes for gamma spectroscopy and 30 to 50 minutes for low background beta determinations are used. The minimum detectable concentration is defined as that concentration at which the statistical two-standard-deviation error is 100 percent of the measured concentration (*1*). Accordingly, the minimum detectable concentrations in units of pc/liter are Sr^{89}, 5; Sr^{90}, 1; I^{131}, 10; Cs^{137}, 5; and Ba^{140}, 10.

[1] Southeastern Radiological Health Laboratory employs a radiochemical procedure for barium–140 analysis.

Data Presentation

Table 1 presents summaries of all available analyses for April 1963, (March 31–April 27, 1963). When a radionuclide is reported by a laboratory as being below minimum detectable concentration, one-half of this value is used in calculating the monthly average. A similar procedure is used for the network average. Although no data are presented on the stable potassium concentrations in milk, analyses have indicated that the usual range of concentrations is from 1.3 to 1.7 grams/liter. In April, for example, 5, 18, 10, 25, and 3 stations reported their respective monthly average potassium concentrations to be 1.3, 1.4, 1.5, 1.6, and 1.7 grams/liter. One station reported 1.1 grams/liter.

Figures 1 and 2 are isonconcentration maps showing the estimated radionuclide concentrations in milk over the entire country. The value printed beside each station is the monthly average concentration for that station.

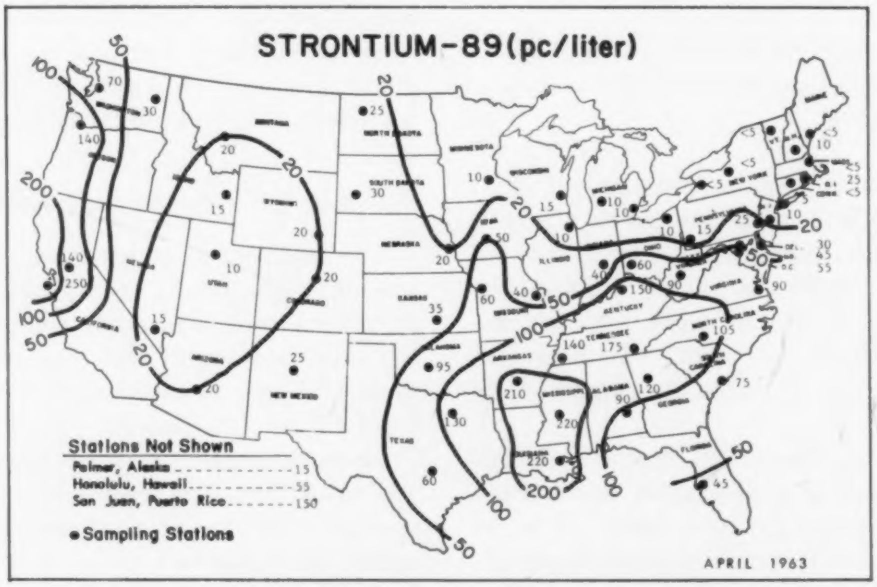

FIGURE 1.—STRONTIUM–89 CONCENTRATIONS IN PASTEURIZED MILK

TABLE 1.—RADIOACTIVITY IN PASTEURIZED MILK, APRIL 1963

[Average radioactivity concentrations in pc/liter]

Sampling locations		Calcium (g/liter)		Strontium–89		Strontium–90		Iodine–131		Cesium–137		Barium–140	
		First quarter 1963	Avg. for month	First quarter 1963	Avg. for month	First quarter 1963	Avg. for month	First quarter 1963	Avg. for month	First quarter 1963	Avg. for month	First quarter 1963	Avg. for month
Ala:	Montgomery	1.26	1.21	85	90	18	22	<10	<10	50	60	10	20
Alaska:	Palmer	1.19	1.20	20	15	11	10	10	<10	65	50	10	<10
Ariz:	Phoenix	1.20	1.18	20	20	4	5	<10	<10	20	15	<10	<10
Ark:	Little Rock	1.23	1.20	125	210	34	50	20	<10	90	150	20	40
Calif:	Sacramento	1.23	1.24	25	140	4	20	10	<10	30	80	10	<10
	San Francisco	1.26	1.26	85	250	8	38	10	<10	35	120	10	<10
Colo:	Denver	1.29	1.23	15	20	11	9	20	<10	65	55	<10	10
Conn:	Hartford	1.11	1.07	<5	<5	12	12	<10	<10	65	60	<10	<10
Del:	Wilmington	1.13	1.06	5	30	17	13	<10	<10	70	70	<10	<10
D.C:	Washington	1.22	1.20	10	55	15	20	<10	<10	60	85	<10	10
Fla:	Tampa	1.24	1.18	50	45	14	12	20	<10	135	185	<10	20
Ga:	Atlanta	1.24	1.23	100	120	21	31	10	<10	85	120	20	20
Hawaii:	Honolulu	1.14	1.19	55	55	8	11	20	<10	55	50	10	<10
Idaho:	Idaho Falls	1.25	1.23	10	15	11	10	10	<10	75	80	<10	<10
Ill:	Chicago	1.13	1.09	<5	10	16	14	<10	<10	70	80	<10	<10
Ind:	Indianapolis	1.15	1.10	10	40	16	19	<10	<10	60	75	<10	<10
Iowa:	Des Moines	1.23	1.22	15	50	14	18	10	<10	65	60	10	<10
Kans:	Wichita	1.25	1.24	20	35	12	12	10	<10	50	55	10	<10
Ky:	Louisville	1.22	1.19	35	150	20	30	<10	<10	55	75	<10	20
La:	New Orleans	1.27	1.22	265	220	37	53	20	20	120	160	30	40
Maine:	Portland	1.14	1.10	<5	<5	20	17	<10	<10	105	100	<10	<10
Md:	Baltimore	1.23	1.14	5	45	14	15	<10	<10	65	80	<10	20
Mass:	Boston	1.14	1.13	<5	<5	19	17	<10	<10	95	90	<10	<10
Mich:	Detroit	1.16	1.10	<5	10	18	11	<10	<10	75	70	<10	<10
	Grand Rapids	1.16	1.08	5	10	15	10	10	<10	75	70	<10	<10
Minn:	Minneapolis	1.20	1.21	15	10	17	16	10	<10	110	95	10	<10
Miss:	Jackson	1.33	1.26	230	220	32	43	20	<10	80	110	30	40
Mo:	Kansas City	1.23	1.22	25	60	14	18	<10	<10	50	45	10	<10
	St. Louis	1.24	1.20	20	40	11	14	10	<10	60	55	20	<10
Mont:	Helena	1.18	1.18	20	20	13	15	10	<10	90	80	20	<10
Nebr:	Omaha	1.25	1.16	20	20	14	16	10	<10	65	65	10	<10
Nev:	Las Vegas	1.18	1.14	10	15	6	4	<10	<10	45	45	10	<10
N.H:	Manchester	1.16	1.10	<5	10	18	16	10	<10	110	110	<10	<10
N.J:	Trenton	1.14	1.10	<5	10	13	19	<10	<10	65	60	<10	<10
N. Mex:	Albuquerque	1.23	1.19	15	25	4	8	<10	<10	30	20	10	<10
N.Y:	Buffalo	1.11	1.06	5	<5	16	14	<10	<10	85	80	<10	<10
	New York	1.12	1.12	<5	5	16	13	<10	<10	65	60	<10	<10
	Syracuse	1.12	1.06	<5	<5	13	14	<10	<10	65	60	<10	<10
N.C:	Charlotte	1.27	1.25	30	105	22	28	<10	<10	60	85	<10	20
N. Dak:	Minot	1.21	1.12	15	25	23	25	<10	<10	85	70	20	<10
Ohio:	Cincinnati	1.11	1.07	15	60	17	20	<10	<10	55	60	<10	<10
	Cleveland	1.12	1.13	<5	10	14	14	<10	<10	60	65	<10	<10
Okla:	Oklahoma City	1.23	1.18	60	95	20	22	20	<10	55	75	10	20
Ore:	Portland	1.25	1.25	55	140	11	29	<10	<10	70	105	20	<10
Pa:	Philadelphia	1.13	1.08	5	25	18	18	<10	<10	65	70	<10	<10
	Pittsburgh	1.13	1.08	5	15	18	15	<10	<10	80	80	<10	<10
P.R:	San Juan	1.20	1.18	135	150	12	20	20	<10	65	115	20	30
R.I:	Providence	1.13	1.10	5	25	16	14	<10	<10	75	80	<10	<10
S.C:	Charleston	1.26	1.23	105	75	23	31	20	<10	80	95	20	20
S. Dak:	Rapid City	1.00	0.92	25	30	13	17	10	<10	80	65	<10	<10
Tenn:	Chattanooga	1.29	1.22	75	175	23	34	<10	<10	65	110	10	20
	Memphis	1.26	1.24	100	140	23	34	10	<10	50	65	20	20
Tex:	Austin	1.22	1.18	50	60	8	11	10	<10	30	45	<10	<10
	Dallas	1.25	1.16	110	130	20	24	20	10	60	75	20	20
Utah:	Salt Lake City	1.26	1.25	15	10	12	12	10	<10	100	80	10	<10
Vt:	Burlington	1.11	1.12	<5	<5	16	18	<10	<10	85	80	<10	<10
Va:	Norfolk	1.25	1.16	30	90	17	22	<10	<10	65	90	<10	20
Wash:	Seattle	1.24	1.25	30	70	10	18	10	<10	75	95	10	<10
	Spokane	1.31	1.24	15	30	12	15	10	<10	85	80	10	<10
W. Va:	Charleston	1.23	1.19	15	90	19	28	<10	<10	50	80	<10	20
Wis:	Milwaukee	1.14	1.12	10	15	11	11	<10	<10	65	70	<10	<10
Wyo:	Laramie	1.24	1.19	20	20	12	13	<10	<10	95	110	20	10
Network average		1.20	1.16	37	59	15.6	19.1	<10	<10	70	79	<10	10

Selected Monthly Strontium–90 Profiles

Continuing the practice followed in previous issues of *RHD*, average monthly strontium–90 concentrations in pasteurized milk from 16 selected cities in the sampling program are presented (see figure 3). Each individual graph shows the strontium–90 concentrations in milk from one city in each of the four U.S. Bureau of Census regions. This method of selection permits the graphical presentation of data from every city in the network at least twice a year.

REFERENCE

(*1*) Division of Radiological Health, Public Health Service: Pasteurized Milk Network, February 1963, *Radiological Health Data*, *4*:291–6, Superintendent of Documents, Government Printing Office, Washington 25, D. C. (June 1963).

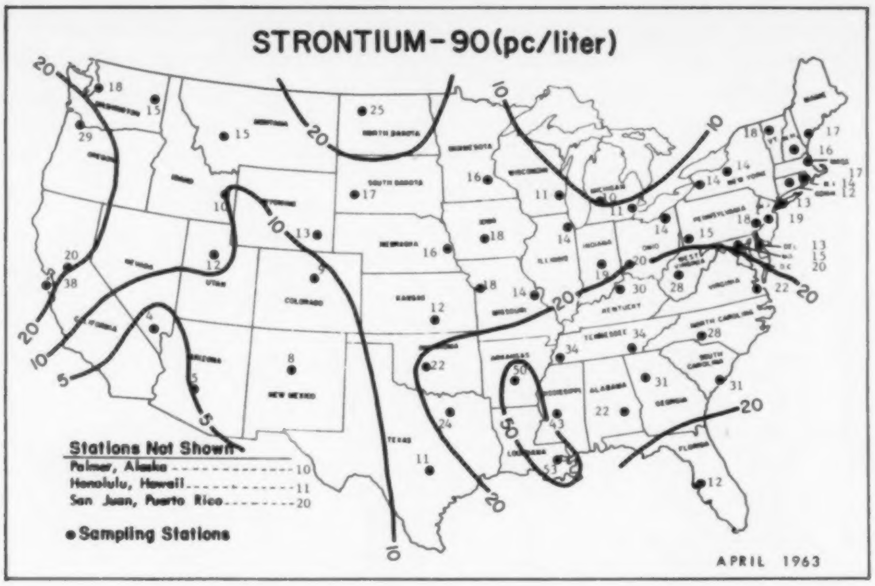

FIGURE 2.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

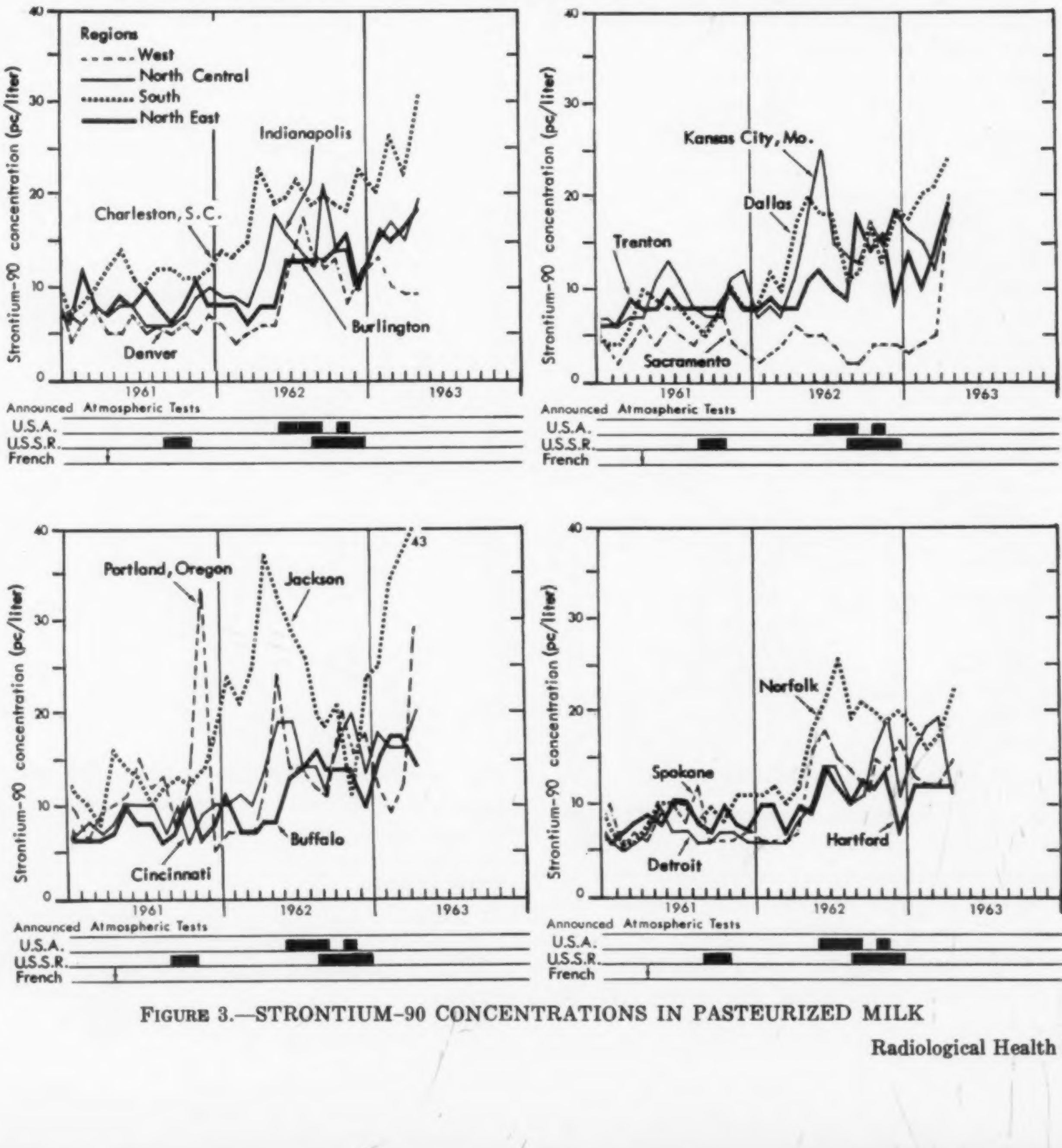

FIGURE 3.—STRONTIUM-90 CONCENTRATIONS IN PASTEURIZED MILK

CALIFORNIA MILK NETWORK
October 1962–March 1963

State of California
Department of Public Health

Surveillance of the concentrations of specific radionuclides in milk is one phase of California's Department of Public Health program of radiation control. This milk monitoring function has been conducted since 1960 by the Department's Bureau of Radiological Health, a constituent of the Division of Environmental Sanitation.

The surveillance program involves the weekly sampling of milk from 10 major milksheds (see figure 4). Radiostrontium is separated chemically and counted in a low background counter. The usual counting time is 60 minutes. Iodine–131, cesium–137, and barium-lanthanum–140 are determined on the fluid milk by gamma scintillation spectroscopy using a sodium iodide crystal. A normal counting time of 100 minutes is used.

The monthly averages of the data are presented in table 2. When the result from an individual analysis was reported as not significant, a value of zero was used in calculating the average.

FIGURE 4.—CALIFORNIA MILKSHEDS

TABLE 2.—RADIONUCLIDES IN CALIFORNIA MILK, OCTOBER 1962-MARCH 1963

[Radioactivity concentrations in pc/liter]

Element and month	Del Norte	Fresno	Humboldt	Los Angeles	Mendocino	Sacramento	San Diego	Santa Clara	Shasta	Sonoma
Calcium (g/liter)										
January 1963	1.36	1.25	1.20	1.13	1.17	1.19	1.17	1.16	1.17	1.22
February 1963	1.35	1.19	1.22	1.14	1.17	1.16	1.15	1.13	1.17	1.21
March 1963	1.33	1.18	1.19	1.11	1.19	1.18	1.14	1.13	1.14	1.20
Strontium–89										
January 1963	581	4	164	5	15	10	66	6	13	31
February 1963	619	5	241	5	20	10	53	6	15	81
March 1963	821	16	258	8	120	34	13	21	39	159
Strontium–90										
January 1963	49	2	12	3	4	3	2	3	4	6
February 1963	56	2	16	2	4	4	2	2	6	7
March 1963	82	6	27	3	11	5	3	5	7	14
Iodine–131										
October 1962	57	[a]0	9	8	8	6	11	0	4	0
November 1962	47	0	78	0	0	6	8	0	0	26
December 1962	86	0	16	0	0	10	3	0	5	23
January 1963	13	0	9	0	0	0	0	0	0	0
February 1963	8	0	2	0	0	0	0	0	0	0
March 1963	0	0	0	0	0	0	0	0	0	0
Cesium–137										
October 1962	[b]215	[c]—	87	[b]23	[b]46	21	20	—	—	[b]22
November 1962	158	18	56	18	30	28	13	14	26	23
December 1962	153	9	54	11	26	23	10	9	35	32
January 1963	105	2	29	10	19	10	2	7	17	21
February 1963	169	15	73	18	26	20	8	16	29	39
March 1963	247	21	84	20	53	28	14	18	39	61
Barium-lanthanum–140										
October 1962	[b]81	—	29	—	[b]0	[b]0	20	—	—	—
November 1962	281	—	42	[b]0	—	—	13	—	—	[b]0
December 1962	87	0	19	0	0	0	10	0	0	4
January 1963	22	0	0	0	0	0	0	0	0	0
February 1963	24	0	6	[b]0	0	0	[b]0	—	[b]0	0
March 1963	—	—	—	—	—	—	—	—	—	—

[a] A zero indicates no significant activity.
[b] Single sample.
[c] A dash indicates no sample.

NEW YORK MILK NETWORK
January–March 1963

Division of Environmental Health Services
State of New York Department of Health

Milk samples, collected routinely from six cities —Albany, Buffalo, Massena, Newburgh, New York City, and Syracuse (figure 5)—are analyzed for radionuclide content by the State of New York Department of Health. Pasteurized milk samples are collected daily and composited weekly for the determination of strontium–89, strontium–90, iodine–131 and cesium–107 at all stations except Massena, where samples are composited bi-weekly, and at New York City, where one daily milk sample representing the total milk supply for that day is obtained and analyzed once per week. Samples are obtained from processing plants except at Albany, where the daily sample is obtained from a marketing point. During periods when cows are no longer on stored feed, the sample from Albany is analyzed for iodine–131 daily. In the event that any city reports iodine–131 concentrations exceeding 100 pc/liter, increased surveillance is undertaken.

The matrix method (1) is used for the analysis of spectral data to determine the concentrations of gamma-emitting nuclides in milk. With this method, the individual nuclide contributions to the gamma spectrum are separated by solution of simultaneous equations describing the spectral interferences.

The analytical procedure for strontium–89 and strontium–90 is based on ion exchange methods. Cations (including radiostrontium) are eluted from the ion exchange resin with sodium chloride solution, strontium isotopes are gathered by means of sodium carbonate, isolated by means of ethylenediaminetetraacetic acid (EDTA), and radiostrontium is counted with a low background beta counter having an 0.8 mg/cm^2 window. The strontium–90 portion is differentially estimated by a second count 40 hours later to determine the rate of growth of its daughter product, yttrium–90.

The monthly average radionuclide concentrations in milk are shown in table 3.

FIGURE 5.—NEW YORK MILK SAMPLING LOCATIONS

TABLE 3.—RADIONUCLIDES IN NEW YORK MILK, JANUARY-MARCH 1963

[Concentrations in pc/liter]

Sampling location	Strontium–89			Strontium–90			Iodine–131			Cesium–137		
	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.	Jan.	Feb.	Mar.
Albany	4	4	<3	6	6	7	<20	<20	<20	54	63	51
Buffalo	5	5	4	8	9	9	<20	<20	<20	62	87	60
Massena	[a]—	9	6	—	10	9	<20	<20	<20	127	117	129
Newburgh	5	7	16	8	6	7	<20	<20	<20	55	61	48
New York City	7	4	4	9	9	8	<20	<20	28	—	—	46
Syracuse	5	5	4	6	5	6	<20	<20	<20	55	28	31

[a] Dash indicates no sample or analysis made.

REFERENCE

(1) Kahn, B., et al.: *Rapid Methods for Estimating Fission Product Concentrations in Milk, Public Health Service Publication No. 999–R–2.* Single free copies may be obtained from Public Inquiries Branch, PHS, U. S. Department of Health, Education, and Welfare, Washington 25, D. C.

CANADIAN MILK NETWORK[1]
March 1963

Radiation Protection Division
Department of National Health and Welfare, Ottawa, Canada

In January 1963, the Canadian Department of National Health and Welfare substituted the radioanalysis of fresh liquid milk for the analysis of powdered milk. The Department had analyzed milk powders from November 1955 through December 1962, but liquid whole milk had been monitored since April 1962 for iodine-131 only.

With this change, it has been possible to choose milk sampling locations (see figure 6) in the same areas as the air and precipitation stations. This permits the observation of a number of environmental variables which may affect the radionuclide levels in milk. In addition, it is now possible to report radionuclide concentrations in terms of the activity per liter of milk as well as per gram of calcium in milk.

A detailed discussion of the sampling and radiochemical procedures employed for milk analyses

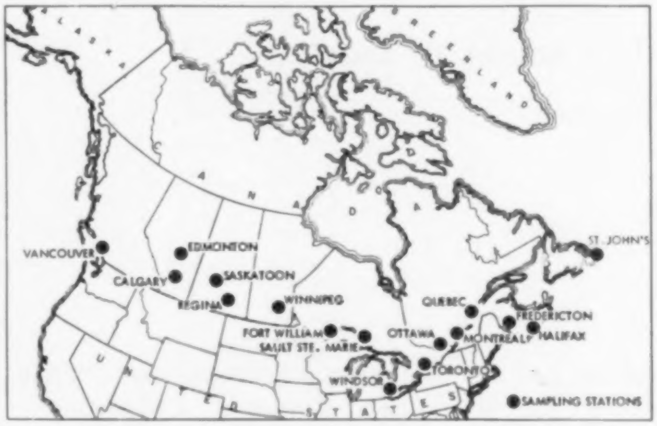

FIGURE 6.—CANADIAN MILK SAMPLING STATIONS

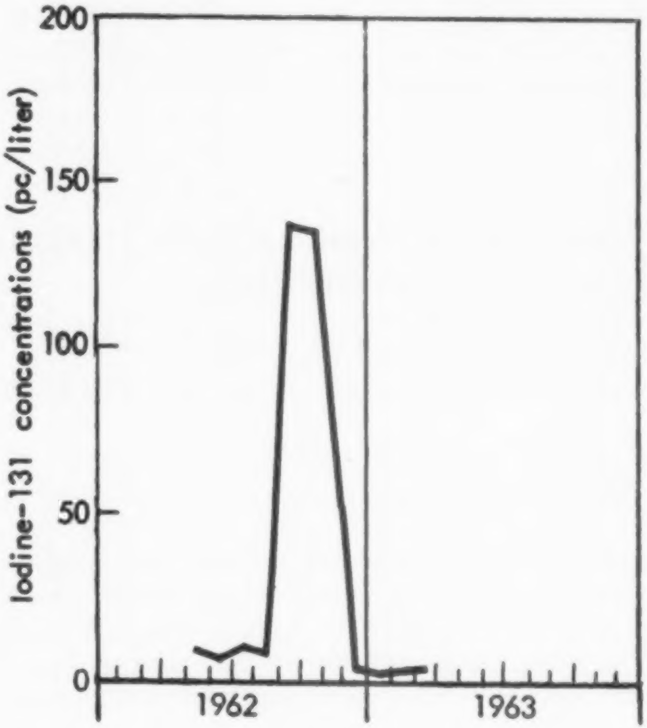

FIGURE 7.—IODINE-131 CONCENTRATIONS IN WHOLE MILK

[1] Data from *Radiation Protection Programs*, Radiation Protection Division, Canadian Department of National Health and Welfare.

TABLE 4.—RADIONUCLIDES IN CANADIAN WHOLE MILK, MARCH 1963

Station	Calcium (g/liter)	Strontium-89 (pc/liter)	Strontium-90 (pc/liter)	Iodine-131 (pc/liter)	Cesium-137 (pc/liter)
Calgary	1.09	16	23.6	9	52
Edmonton	1.14	9	19.6	[b]—	42
Fort William	1.13	13	26.6	—	58
Fredericton	1.27	4	28.2	—	116
Halifax	1.27	11	19.9	3	84
Montreal	1.18	12	16.4	—	40
Ottawa	1.15	12	12.3	4	31
Quebec	1.15	4	22.5	2	91
Regina	1.01	8	17.5	—	19
Saint John's	1.14	14	19.5	—	17
Saskatoon	1.17	25	14.2	15	36
Sault Ste. Marie	1.10	183	18.1	3	54
Toronto	1.13	11	10.8	—	74
Vancouver	1.24	8	20.4	1	67
Windsor	1.19	11	11.2	0	28
Winnipeg	1.18	13	17.8	0	32
Average	1.16	22	18.7	4	53

[a] Each of the iodine-131 values is an average of nine samples.
[b] A dash indicates no sample.

may be found in the Department's publications (*1, 2*). Table 4 presents the results of the measurements of strontium–89, strontium–90, cesium–137, and iodine–131 (see figure 7) in Canadian liquid whole milk for March.

It should be emphasized that the interpretation of fallout data in relation to health is a complex problem. In comparing the concentration levels in a particular medium with the so-called Maximum Permissible Concentrations (MPC's) as established by the International Commission on Radiological Protection (*3*), it is necessary to keep in mind that the MPC values refer to conditions of continuous exposure over a lifetime. Therefore, the average levels over an extended period, such as one year, represent a better basis for comparison than do individual levels at any specific time.

REFERENECS

(*1*) Radiation Protection Division, Department of National Health and Welfare, Ottawa, Canada: *The Preliminary Report on the Measurements of Radioactive Strontium in Canadian Milk Powder Samples, CNHW–RP–1*, (July 1958).

(*2*) Mar, Peter G.: *Outline of Procedure for the Radiochemical Analysis of Dried Milk Powders for Strontium and Yttrium, RPD–5*, Radiation Protection Division, Department of National Health and Welfare (June 1, 1960).

(*3*) Recommendations of the International Commission on Radiological Protection: *Report of Committee II on Permissible Dose for Internal Radiation*, Pergamon Press, New York (1959).

Twelve-Month Sum of Daily Radionuclide Content of One Liter of Pasteurized Milk

Iodine–131: June 1962–May 1963
Strontium–89 and Strontium–90: May 1962–April 1963

Division of Radiological Health,
Public Health Service

The guidance of the Federal Radiation Council (FRC) is given in terms of transient rates of intake of radioactive materials in picocuries per day. The action ranges proposed in FRC Report No. 2 are based on radiation doses considered acceptable for lifetime exposure from normal peacetime atomic industry operations (*1*). The Council recommends the use of a time period of one year as an appropriate interval for averaging exposures and emphasizes that the annual acceptable exposure dose is not a "danger point" which, if exceeded, requires protective measures (*1, 2, 3*).

To facilitate comparison of the concentrations of certain radionuclides in milk with the Radiation Protection Guides, tables 1 and 2 furnish estimates of the contribution of milk to the total dietary intake of iodine–131, strontium–89, and strontium–90. The tables are developed from the PHS Pasteurized Milk Network monthly averages of the radionuclides. The index values are estimated sums of the daily amounts of a radionculide in one liter of milk for a 12-month period.

The tables show 12-month index values for each of the Network's 62 sampling locations. Due to the longer time required for strontium–89 and strontium–90 analysis, these 12-month index values are for the year beginning one month earlier than the iodine–131 values. Columns (B) and (C) in each table are used to compute the net change as the yearly index values are advanced by one month. Column (D) shows this new 12-month index value. In addition, the second column in table 1 gives the average iodine–131 concentrations for May 1963.

The data in tables 1 and 2 are calculated as follows: (a) results from all samples collected in each week (Sunday through Saturday) are averaged, (b) the weekly averages for all weeks ending within a given month are averaged and an average for the month is obtained, and (c) the monthly radionuclide index value is determined by multiplying the average for the month by the number of days in the month. The number of days in the month will be either 28 or 35, corresponding to the complete calendar weeks ending in a given month. Procedures exemplified by (a) and (b) above tend to minimize the effect of any one day's sample results on the average for the month, particularly for a short-lived radionuclide such as iodine–131. The yearly index values are obtained by the following procedure. Column (A) gives twelve month index values for the period indicated. Columns

TABLE 1.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF IODINE-131 IN ONE LITER OF MILK

Sampling locations		May 1963 iodine-131 averages (pc/liter)	Iodine-131 index values[a] (pc day/liter)			
			May 1962–Apr. 1963 (A)	Apr. 29–May 26, 1962 (B)	Apr. 28–May 25, 1963 (C)	June 1962–May 1963 (D)
Ala:	Montgomery	<10	6,590	560	140	6,170
Alaska:	Palmer	<10	38,050	140	140	38,050
Ariz:	Phoenix	<10	4,100	140	140	4,100
Ark:	Little Rock	<10	14,480	560	140	14,420
Calif:	Sacramento	<10	5,050	560	140	4,630
	San Francisco	<10	4,630	140	140	4,630
Colo:	Denver	<10	6,240	280	140	6,100
Conn:	Hartford	<10	7,670	140	140	7,670
Del:	Wilmington	<10	11,870	140	140	11,870
D.C:	Washington	<10	8,440	140	140	8,440
Fla:	Tampa	<10	6,660	140	140	6,660
Ga:	Atlanta	<10	9,040	280	140	8,900
Hawaii:	Honolulu	<10	4,730	280	140	4,590
Idaho:	Idaho Falls	<10	9,070	140	140	9,070
Ill:	Chicago	<10	13,690	1,120	140	12,710
Ind:	Indianapolis	<10	12,010	280	140	11,870
Iowa:	Des Moines	<10	21,670	2,520	140	19,290
Kans:	Wichita	<10	21,740	6,160	140	15,720
Ky:	Louisville	<10	10,540	560	140	10,120
La:	New Orleans	<10	10,190	140	140	10,190
Maine:	Portland	<10	8,160	140	140	8,160
Md:	Baltimore	<10	8,690	560	140	8,270
Mass:	Boston	<10	7,950	140	140	7,950
Mich:	Detroit	<10	12,820	280	140	12,680
	Grand Rapids	<10	9,730	140	140	9,730
Minn:	Minneapolis	<10	15,650	3,360	140	12,430
Miss:	Jackson	<10	9,700	140	140	9,700
Mo:	Kansas City	<10	30,070	5,600	140	24,610
	St. Louis	<10	12,360	840	140	11,660
Mont:	Helena	<10	14,110	280	140	13,970
Nebr:	Omaha	<10	19,220	840	140	18,520
Nev:	Las Vegas[b]	<10	4,730	[c]—	140	4,870
N.H:	Manchester	<10	7,710	140	140	7,710
N.J:	Trenton	<10	7,990	140	140	7,990
N. Mex:	Albuquerque	<10	6,380	560	140	5,960
N.Y:	Buffalo	<10	8,720	140	140	8,720
	New York	<10	11,660	560	140	11,240
	Syracuse	<10	10,150	560	140	9,730
N.C:	Charlotte	<10	3,370	140	140	3,370
N. Dak:	Minot	<10	14,910	560	140	14,490
Ohio:	Cincinnati	<10	14,600	560	140	14,180
	Cleveland	<10	11,100	140	140	11,100
Okla:	Oklahoma City	<10	18,380	560	140	17,960
Ore:	Portland	<10	9,770	140	140	9,770
Pa:	Philadelphia	<10	10,820	140	140	10,820
	Pittsburgh	<10	14,810	140	140	14,810
P.R:	San Juan[d]	<10	6,130	560	140	5,710
R.I:	Providence	<10	8,580	560	140	8,160
S.C:	Charleston	<10	7,180	140	140	7,180
S. Dak:	Rapid City	<10	14,150	140	140	14,150
Tenn:	Chattanooga	<10	7,850	560	140	7,430
	Memphis	<10	10,050	140	140	10,050
Tex:	Austin	<10	11,040	140	140	11,040
	Dallas	<10	18,980	560	140	18,560
Utah:	Salt Lake City	<10	31,920	140	140	31,920
Vt:	Burlington	<10	8,380	140	140	8,380
Va:	Norfolk	<10	6,410	280	140	6,270
Wash:	Seattle	<10	9,770	140	140	9,770
	Spokane	<10	21,390	140	140	21,390
W. Va:	Charleston	<10	6,970	560	140	6,550
Wis:	Milwaukee	<10	14,460	280	140	14,320
Wyo:	Laramie	<10	19,540	560	140	19,120

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. The average per-person annual iodine-131 intake from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration
Example: 12-month I^{131} index × milk consumption factor = 12-month I^{131} intake
(pc day/liter) (liter/day/person) (pc/person)

[b] Station included in milk network in July 1962. The sums in columns A and D are therefore for 10 and 11 months respectively.

[c] A dash indicates no analysis.

[d] No sample was received in November 1962. The sums in columns A and D are therefore for 11 months.

TABLE 2.—TWELVE-MONTH SUM OF DAILY AMOUNTS OF STRONTIUM-89 AND STRONTIUM-90 IN ONE LITER OF MILK

[pc day/liter]

Sampling locations		Strontium-89 index values[a]				Strontium-90 index values[a]			
		Apr. 1962–Mar. 1963 (A)	Apr. 1-28, 1962 (B)	Mar. 31, 1963–Apr. 27, 1963 (C)	May 1962–Apr. 1963 (D)	Apr. 1962–Mar. 1963 (A)	Apr. 1-28, 1962 (B)	Mar. 31, 1963–Apr. 27, 1963 (C)	May 1962–Apr. 1963 (D)
Ala:	Montgomery	23,905	4,760	2,520	21,665	5,866	644	616	5,838
Alaska:	Palmer	19,985	420	420	19,985	4,095	168	280	4,207
Ariz:	Phoenix	6,425	560	560	6,425	1,211	84	140	1,267
Ark:	Little Rock	49,665	10,640	5,880	44,905	11,767	1,120	1,400	12,047
Calif:	Sacramento	7,720	1,260	3,920	10,380	1,456	168	560	1,848
	San Francisco	15,645	2,240	7,000	20,405	2,212	280	1,064	2,996
Colo:	Denver	10,920	280	560	11,200	4,039	168	252	4,123
Conn:	Hartford	8,140	140	70	8,070	4,158	280	336	4,214
Del:	Wilmington	12,935	1,540	840	12,235	5,453	392	364	5,425
D.C:	Washington	13,020	1,120	1,540	13,440	5,817	336	560	6,041
Fla:	Tampa	11,690	840	1,260	12,110	4,081	252	236	4,165
Ga:	Atlanta	28,980	4,900	3,360	27,440	7,119	700	868	7,287
Hawaii:	Honolulu	10,885	1,120	1,540	11,305	2,114	168	308	2,254
Idaho:	Idaho Falls	9,275	140	420	9,555	3,871	112	280	4,039
Ill:	Chicago	10,800	70	280	11,010	4,893	196	392	5,089
Ind:	Indianapolis	13,790	840	1,120	14,070	5,418	336	532	5,614
Iowa:	Des Moines	24,710	840	1,400	25,270	5,250	224	504	5,530
Kans:	Wichita	18,270	980	980	18,270	4,543	224	336	4,655
Ky:	Louisville	28,840	3,080	4,200	29,960	7,868	504	840	8,204
La:	New Orleans	57,260	7,980	6,160	55,440	11,746	1,120	1,484	12,110
Maine:	Portland	10,800	70	70	10,800	5,852	364	476	5,964
Md:	Baltimore	12,005	840	1,260	12,425	5,824	308	420	5,936
Mass:	Boston	11,430	70	70	11,430	6,657	336	476	6,797
Mich:	Detroit	9,855	140	280	9,995	5,033	224	308	5,117
	Grand Rapids	8,560	70	280	8,770	4,249	224	280	4,305
Minn:	Minneapolis	20,860	140	280	21,000	6,811	140	448	7,119
Miss:	Jackson	55,825	9,520	6,160	52,465	9,576	1,036	1,204	9,744
Mo:	Kansas City	31,430	1,680	1,680	31,430	5,775	308	504	5,971
	St. Louis	20,090	1,120	1,120	20,090	5,173	280	392	5,285
Mont:	Helena	17,395	560	560	17,395	4,984	112	420	5,292
Nebr:	Omaha	21,560	840	560	21,280	5,372	168	448	5,652
Nev:	Las Vegas[b]	5,775	[c]—	420	6,195	1,512	—	112	1,624
N.H:	Manchester	10,415	70	280	10,625	5,789	308	448	5,929
N.J:	Trenton	9,995	560	280	9,715	4,396	224	532	4,704
N. Mex:	Albuquerque	6,795	560	700	6,935	1,666	84	224	1,806
N.Y:	Buffalo	8,980	70	70	8,980	4,858	224	392	5,026
	New York	10,555	70	140	10,625	5,551	252	364	5,663
	Syracuse	9,540	70	70	9,540	4,564	224	392	4,732
N.C:	Charlotte	20,860	3,500	2,940	20,300	7,791	476	784	8,099
N. Dak:	Minot	17,650	140	700	18,210	8,106	196	700	8,610
Ohio:	Cincinnati	17,325	1,680	1,680	17,325	5,831	392	560	5,999
	Cleveland	10,730	70	280	10,940	4,781	252	392	4,921
Okla:	Oklahoma City	27,160	2,660	2,660	27,160	7,007	448	616	7,175
Ore:	Portland	32,270	2,240	3,920	33,950	5,257	336	812	5,733
Pa:	Philadelphia	10,415	560	700	10,555	5,250	308	504	5,446
	Pittsburgh	12,340	280	420	12,480	6,223	308	420	6,335
P.R:	San Juan[d]	26,355	3,220	4,200	27,335	3,766	336	560	3,990
R.I:	Providence	9,190	140	700	9,750	5,131	308	392	5,215
S.C:	Charleston	26,845	4,060	2,100	22,885	7,623	644	868	7,847
S. Dak:	Rapid City	21,315	280	840	21,875	6,083	196	476	6,363
Tenn:	Chattanooga	39,305	9,520	4,900	34,685	8,582	812	952	8,722
	Memphis	36,645	6,720	3,920	33,845	8,351	784	952	8,519
Tex:	Austin	12,285	1,260	1,680	12,705	2,814	224	308	2,898
	Dallas	32,305	4,480	3,640	31,465	6,202	476	672	6,398
Utah:	Salt Lake City	12,005	140	280	12,145	3,941	112	336	4,165
Vt:	Burlington	11,045	70	70	11,045	4,844	224	504	5,124
Va:	Norfolk	17,920	2,100	2,520	18,340	6,909	336	616	7,189
Wash:	Seattle	23,065	1,400	1,960	23,625	5,740	280	504	5,964
	Spokane	14,280	560	840	14,560	5,033	196	420	5,257
W. Va:	Charleston	21,595	980	2,520	23,135	7,448	336	784	7,896
Wis:	Milwaukee	8,665	70	420	9,015	3,549	168	308	3,689
Wyo:	Laramie	20,440	280	560	20,720	4,263	112	364	4,515

[a] The data in this table are index values, not to be interpreted as consumption or total intake values. The average per-person annual strontium-89 and strontium-90 intake from milk may be calculated from an index value in this table by applying the appropriate factor representing average individual daily milk consumption for any selected group under consideration.

Example: 12-month Sr^{89} or Sr^{90} index × milk consumption factor = 12-month Sr^{89} or Sr^{90} intake
(pc day/liter) (liter/day/person) (pc/person)

[b] Station included in network in July 1962. Sums in columns A and D are therefore for 9 and 10 months, respectively.

[c] A dash indicates no analysis.

[d] No sample was received for November 1962. The sums in columns A and D are therefore for 11 months.

(B) and (C) show the monthly index values for the periods indicated. The values in column (D) are obtained by adding the values in column (C) to those in column (A) and subtracting those in (B).

For a number of reasons, it is desirable to use a standard quantity of milk in the development of index values for the different radionuclides. When one is concerned with radio-strontium, 1 liter is a suitable quantity, as this amount of milk supplies approximately 1 gram of calcium, the amount used by the Federal Radiation Council in deriving the daily intake guidance for radio-strontium. When one is concerned with iodine–131, the critical age group is the young infant. Available information suggests that the average milk consumption of infants in the 6–18-month group is not more than 1 liter per day. Thus, the index value based on 1 liter of milk, though not directly an average intake value, is probably the most useful index for estimating total intake.

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SECTION IV.—WATER

Radioactivity in Raw Surface Waters

NATIONAL WATER QUALITY NETWORK
February 1963

Division of Water Supply and Pollution Control, Public Health Service

Levels of radioactivity in surface waters of the United States have been under surveillance by the Public Health Service National Water Quality Network since its initiation in 1957. Beginning with the establishment of 50 sampling points, this network has expanded to 126 stations as of June 1, 1963, (figure 1), operated jointly with State, Federal and local agencies and industry. Surface waters of all major river basins of the United States are sampled and analyzed physically, chemically, biologically and radiologically. These data can then be used to evaluate sources of radioactivity which may effect all legitimate uses of surface water. Further, the Network provides background information necessary for recognizing pollution and water quality trends and for determining levels of radioactivity to which the population may be subjected. Data assembled through the Network are published in an annual compilation (*1–6*).

FIGURE 1.—TOTAL BETA ACTIVITY (pc/liter) IN SURFACE WATER AT NATIONAL WATER QUALITY NETWORK SAMPLING STATIONS, FEBRUARY 1963

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS

[Average concentration in pc/liter]

Station	February 1963 Beta activity Suspended	February 1963 Beta activity Dissolved	February 1963 Beta activity Total	February 1963 Alpha activity Suspended	February 1963 Alpha activity Dissolved	February 1963 Alpha activity Total
Allegheny River: Pittsburgh, Pa	4	16	20	0	0	0
Animas River: Cedar Hill, N. Mex	142	44	186	22	4	26
Apalachicola River: Chattahoochee, Fla	37	21	58	1	0	1
Arkansas River						
Coolidge, Kans	28	64	92	4	24	28
Ponca City, Okla	42	42	84	3	1	4
Bear River: Preston, Idaho	50	92	142	1	2	3
Bighorn River: Hardin, Mont	90	64	154	7	6	13
Big Sioux River: Sioux Falls, S. Dak	9	40	49	0	2	2
Chattahoochee River						
Atlanta, Ga	19	8	27	1	0	1
Columbus, Ga	30	15	45	0	0	0
Lanett, Ala	96	28	124	2	<1	2
Chena Slough: Fairbanks, Alaska	[2]—	—	—	—	—	—
Clear Water River: Lewiston, Idaho	163	26	189	10	0	10
Clinch River						
Clinton, Tenn	14	16	30	1	0	1
Kingston, Tenn	191	560	751	2	<1	2
Colorado River						
Loma, Colo	90	60	150	7	6	13
Page, Ariz	5	53	58	1	12	13
Boulder City, Nev	1	13	14	0	6	6
Parker Dam, Calif-Ariz	0	29	29	0	6	6
Yuma, Ariz	1	25	26	0	4	4
Columbia River						
Northport, Wash	7	12	19	<1	1	1
Wenatchee, Wash	3	11	14	0	0	0
Pasco, Wash	32	342	374	0	0	0
McNary Dam, Ore	44	210	254	<1	<1	1
Bonneville, Ore	73	196	269	0	0	0
Clatskanie, Ore	54	90	144	—	—	—
Cumberland River: Clarksville, Tenn	13	16	29	1	0	1
Connecticut River						
Wilder, Vt	6	13	19	0	1	1
Northfield, Mass	3	10	13	1	0	1
Enfield Dam, Conn	0	14	14	0	0	0
Cuyahoga River: Cleveland, Ohio	4	17	21	0	1	1
Deleware River						
Martins Creek, Pa	6	11	17	0	0	0
Trenton, N.J	—	—	—	—	—	—
Philadelphia, Pa	46	32	78	1	1	2
Great Lakes						
Duluth, Minn	0	3	3	0	0	0
Sault Ste. Marie, Mich	1	6	7	0	0	0
Milwaukee, Wis	0	9	9	0	1	1
Gary, Ind	1	7	8	0	0	0
Port Huron, Mich	0	7	7	0	0	0
Detroit, Mich	2	8	10	0	0	0
Buffalo, N.Y	10	15	25	0	0	0
Green River: Dutch John, Utah	7	34	41	0	6	6
Hudson River: Poughkeepsie, N.Y	5	13	18	0	0	0
Illinois River						
Peoria, Ill	7	24	31	1	5	6
Grafton, Ill	—	—	—	—	—	—
Kanawha River: Winfield Dam, W. Va	12	40	52	2	20	22
Klamath River: Keno, Ore	46	35	81	0	0	0
Little Miami River: Cincinnati, Ohio	33	70	103	0	0	0
Maumee River: Toledo, Ohio	12	40	52	<1	2	2
Merrimack River: Lowell, Mass	8	22	30	<1	<1	1
Mississippi River						
St. Paul, Minn	0	13	13	0	0	0
Dubuque, Iowa	4	16	20	1	1	2
Burlington, Iowa	3	20	23	0	0	0
E. St. Louis, Ill	5	21	26	0	1	1
Cape Giraudeau, Mo	7	23	30	1	1	2
W. Memphis, Ark	39	22	61	1	0	1
Delta, La	28	21	49	2	1	3
New Orleans, La	19	22	41	0	0	0
Vicksburg, Miss	61	25	86	3	1	4
Missouri River						
Williston, N. Dak	53	64	117	0	3	3
Bismarch, N. Dak	0	15	15	0	2	2
Yankton, S. Dak	—	—	—	—	—	—
Omaha, Nebr	5	26	31	0	4	4
St. Joseph, Mo	21	27	48	1	4	5
Kansas City, Kans	4	20	24	1	6	7
St. Louis, Mo	15	37	52	3	3	6
Missouri City, Mo	24	38	62	3	7	10
Monongahela River: Pittsburgh, Pa	13	25	38	0	0	0
North Platte River: Henry, Nebr	15	53	68	<1	30	30
Ohio River						
E. Liverpool, Ohio	14	14	28	1	1	2
Addison, Ohio	15	24	39	<1	<1	1
Huntington, W. Va	29	18	47	2	1	3
Cincinnati, Ohio	24	17	41	2	0	2
Louisville, Ky	—	—	—	—	—	—
Evansville, Ind	36	16	52	1	0	1
Cairo, Ill	45	15	60	12	1	13
Ouachita River: Bastrop, La	100	87	187	3	4	7
Pend Oreille River: Albeni Falls Dam, Idaho	10	14	24	0	<1	<1
Platte River: Plattsmouth, Nebr	20	36	56	1	6	7
Potomac River						
Williamsport, Md	7	11	18	0	0	0
Great Falls, Md	11	33	44	0	0	0
Rainy River						
Baudette, Minn	10	21	31	1	1	2
International Fls, Minn	2	22	24	0	0	0
Red River, South						
Denison, Tex	13	45	58	0	12	12
Index, Ark	9	30	39	0	0	0
Alexandria, La	44	38	82	1	2	3
Bossier City, La	24	61	85	0	<1	<1
Rio Grande River						
Alamosa, Colo	4	19	23	0	1	1
El Paso, Tex	22	63	85	2	0	2
Laredo, Tex	36	50	86	0	1	1
Brownsville, Tex	14	22	36	0	4	4
Roanoke River: John H. Kerr Resr. & Dam, Va	27	13	40	1	0	1
Sabine River: Ruliff, Tex	49	43	92	0	0	0
Sacramento River: Greens Landing Courtland, Calif	47	20	67	1	1	2
San Joaquin River: Vernalis, Calif	32	33	65	2	1	3
San Juan River: Shiprock, N. Mex	38	46	84	2	12	14
St. Lawrence River: Massena, N.Y	0	8	8	0	0	0
Schuylkill River: Philadelphia, Pa	25	31	56	1	6	7
Savannah River						
North Augusta, Ga	32	26	58	0	0	0
Port Wentworth, Ga	42	56	98	1	0	1
Shenandoah River: Berryville, Va	6	15	21	0	0	0
Ship Creek: Anchorage, Alaska	9	13	22	1	0	1
Snake River						
Ice Harbor Dam, Wash	15	26	41	1	2	3
Wawawai, Wash	42	24	66	1	1	2
Payette, Idaho	28	33	61	1	3	4
South Platte River: Julesburg, Colo	54	83	137	4	33	37
Spokane River: Post Falls, Idaho	12	17	29	0	0	0
Susquehanna River						
Sayre, Pa	7	12	19	0	0	0
Conowingo, Md	6	14	20	0	1	1
Tennessee River						
Chattanooga, Tenn	46	56	102	1	0	1
Bridgeport, Ala	8	55	63	0	0	0
Pickwick Landing, Tenn	29	44	73	0	0	0
Lenoir City, Tenn	32	31	63	1	1	2
Tombigbee River: Columbus, Miss	—	—	—	—	—	—

TABLE 1.—RADIOACTIVITY IN RAW SURFACE WATERS—Continued

[Average concentrations in pc/liter]

Station	Beta activity			Alpha activity		
	Suspended	Dissolved	Total	Suspended	Dissolved	Total
Truckee River: Farad, Calif.	4	6	10	0	0	0
Verdigris River: Nowata, Okla.	9	45	54	1	1	2
Wabash River: New Harmony, Ind.	23	67	90	<1	1	1
Willamette River: Portland, Ore.	15	15	30	0	0	0
Yakima River: Richland, Wash.	31	21	52	1	1	2
Yellowstone River: Sidney, Mont.	43	42	85	1	4	5

[1] These data are preliminary: reanalysis of some samples may be made and additional analyses, not completed at the time of the report, may become available. For final data one should consult the Network's *Annual Compilation of Data* (6).
[2] Dashes indicate data are not available.

One-liter grab samples are collected weekly by personnel of the participating agencies and shipped to the Public Health Service laboratory in Cincinnati for analysis. Determinations of gross alpha and gross beta radioactivity in the suspended and dissolved solids and strontium-90 activity in the total solids are carried out on frequency schedules based on need.

Gross beta activity in each weekly sample was determined until essentially background levels were reached in January 1960. Then, gross beta determinations were made on monthly composites of the weekly samples received from all stations, except those located downstream from known potential sources of radioactive waste and those from all newly established Network stations. (Weekly alpha and beta measurements are scheduled routinely during the first year of operation at newly established stations.) On September 1, 1961, weekly determinations of gross beta activity again were initiated to permit rapid evaluation of fallout effects from renewed weapons testing. This practice was continued until the end of October 1962, when samples for gross beta analysis were again composited monthly. Gross alpha determinations were made once monthly except where variable or high values observed during the first year indicated the need for more frequent measurement.

Normally, samples are counted at the Network laboratory within two weeks following collection or within one week after compositing. The decay of activity is followed on each sample that shows unusually high activity during the first analysis. Also if a recount indicates that the original analysis was questionable, values based on recounting are recorded. All results are reported for the time of counting and are not corrected by extrapolation to the time of collection.

The analytical method used for determining gross alpha and beta radioactivity is described in the eleventh edition of "Standard Methods for the Examination of Water and Wastewater" (*7*). Suspended and dissolved solids are separated by passing the sample through a membrane filter (type HA) with a pore size of 0.45 microns. Planchets are then prepared for counting the dissolved solids (in the filtrate) and the suspended solids (on the charred filter membrane) for counting in an internal proportional counter. Since the fourth quarter of 1958, strontium-90 analyses have been made on three-month composites of aliquots from weekly samples. Therefore strontium-90 results will be presented on a quarterly basis. Until the fourth quarter of 1961, the method used for determining strontium-90 was that described in the aforementioned reference (*7*). Tributylphosphate was used to extract ingrown yttrium-90 from the purified, coprecipitated strontium-90. Since that time, a modification of a procedure described by Harley has been used (*8*). The yttrium-90, together with an yttrium carrier is precipitated at pH 8.5; the precipitate is washed, redissolved, and reprecipitated as yttrium oxalate and the latter is washed and counted in a low-background, anticoincidence, end-window proportional counter.

Table 1 presents February 1963 results of alpha and beta analyses of U.S. raw surface waters. These data are preliminary; reanalysis of some samples may be made and additional analyses, not completed at the time of this report, may become available. For final data one should consult the Network's *Annual Compilation of Data* (*6*). The figures for gross alpha and gross beta radioactivity represent determinations made on composite samples or means of weekly determinations where composites were not made.

In order to obtain a geographical perspective of the radioactivity in surface water, the numbers alongside the various stations in figure 1 give the total beta activity in suspended-plus-dissolved-solids in raw water collected at that station. Network results for the years 1957–1962 have been summarized by Weaver et al (9).

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(6) Ibid., 1963 Edition (to be published).

(7) American Public Health Association, American Water Works Association and Water Pollution Control Federation: *Standard Methods for the Examination of Water and Wastewater*, 11th Edition, New York (1960).

(8) Harley, J. H.: Radiochemical Determination of Strontium-90, *Health and Safety Laboratory Manual of Standard Procedures*, August 1962 Revision, Radiochemistry and Environmental Studies Division, U. S. Atomic Energy Commission, New York Operations Office (1962).

(9) Weaver, L., A. W. Hoadley, and S. Baker: Radioactivity in Surface Waters of the United States, 1957–1962, *Radiological Health Data*, 4:306–16, Superintendent of Documents, Government Printing Office, Washington 25, D. C. (June 1963).

Radionuclide Analyses of Coast Guard Water Supplies

May 1962–December 1962

U.S. Coast Guard and Division of Radiological Health, Public Health Service

From 1957 through 1960, monthly samples of several U.S. Coast Guard light station cistern supplies were routinely analyzed for beta activity by the Robert A. Taft Sanitary Engineering Center (1). Low radioactivity concentrations two years after the 1958 cessation of nuclear weapons testing led to the termination of this sampling procedure.

FIGURE 1.—COAST GUARD LORAN STATION WATER SAMPLING LOCATIONS

TABLE 1.—RADIONUCLIDES IN WATER SAMPLES FROM U. S. COAST GUARD LORAN STATIONS, MAY 1962—DECEMBER 1962

[Concentrations in pc/liter]

Alaskan location	1962 Collection date	Gross alpha	Gross beta	Sr^{90}	Ra^{226}	I^{131}	Ba^{140}	Cs^{137}	Zr^{95}
Adak	May 11	5.4	9400	106	[a]—	<10	10	< 5	2300
Attu	May 11	[b]ND	45	2.0	—	<10	45	< 5	50
	May 22	ND	29	2.4	0.1	<10	10	< 5	30
	June 29	1.2	15	0.8	—	<10	<10	< 5	35
	August 10	1.9	7	0.5	0.2	<10	<10	< 5	<10
	September 8	ND	13	0.7	—	<10	<10	< 5	<10
	October 9	ND	13	1.6	1.5	40	20	< 5	<10
	November 13	ND	7	1.0	ND	<10	<10	< 5	<10
	December 8	1.4	26	—	—	<10	<10	< 5	<10
Biorka	May 8	2.1	57	1.6	—	<10	<10	< 5	60
	June 14	1.4	53	2.3	—	<10	20	< 5	20
	July 17	Lost	Lost	9.8	ND	<10	50	<10	10
	August 14	ND	9	3.3	—	<10	<10	< 5	10
	September 8	0.5	45	0.8	—	<10	<10	< 5	< 5
	October 9	ND	87	0.2	ND	<10	<10	< 5	< 5
	November 12	0.6	10	2.0	ND	<10	90	< 5	50
	December 13	ND	80	—	—	<10	110	< 5	< 5
Cape Sarichef	May 12	0.6	12	0.4	—	<10	<10	< 5	< 5
	June 20	ND	96	1.0	—	<10	<10	< 5	< 5
	July 14	ND	5	ND	ND	20	<10	15	<10
	August 14	ND	ND	ND	0.5	50	90	90	<10
	September 9	ND	5	0.1	—	<10	<10	< 5	<10
	October 9	ND	ND	1.9	ND	<10	<10	< 5	<10
	November 9	ND	4	1.0	ND	<10	<10	< 5	<10
	December 21	0.8	14	—	—	200	<10	110	<10
Port Clarence	May 17	1.1	0.3	0.4	—	<10	<10	< 5	< 5
	June 4	ND	4	0.4	—	<10	<10	< 5	<10
	June 15	ND	34	Lost	ND	<10	<10	< 5	< 5
	August 15	3.3	10	0.9	—	<10	<10	< 5	<10
	September 13	0.6	9	2.3	—	<10	<10	< 5	<10
	October 6	0.5	12	ND	—	90	180	20	< 5
	November 7	1.1	13	ND	ND	<10	<10	< 5	<10
	December 15	ND	13	—	—	<10	<10	< 5	<10
Sitkinak	May 15	0.8	20	1.1	—	<10	<10	< 5	< 5
	June 20	ND	60	22.1	—	<10	<10	< 5	< 5
	July 19	0.7	14	1.9	ND	<10	<10	5	<10
	August 28	ND	10	0.8	ND	40	<10	< 5	<10
	October 22	ND	11	1.0	ND	<10	<10	< 5	<10
	November 13	ND	11	ND	ND	<10	<10	< 5	<10
	December 10	0.7	34	ND	ND	<10	<10	< 5	<10
Spruce Cape	May 8	0.9	19	1.2	—	<10	35	< 5	< 5
	June 13	0.8	23	1.2	0.1	<10	15	< 5	10
	July 10	1.7	3	0.3	—	<10	10	< 5	15
	August 12	0.8	18	[c]IS	IS	<10	<10	< 5	<10
	August 16	ND	8	1.4	0.4	<10	<10	< 5	<10
	October 11	ND	16	ND	ND	<10	<10	< 5	<10
	November 6	0.8	11	ND	ND	<10	60	< 5	<10
	December 11	ND	113	—	—	<10	<10	< 5	40

[a] Dash indicates results not reported.
[b] ND indicates activity not detectable.
[c] IS indicates insufficient sample.

Since October 1961, drinking water samples have been obtained from Coast Guard Loran Stations in Alaska. In most cases, these samples are collected from small artificial impoundments or lakes. The sampling sites are shown in figure 1.

The radionuclide analyses reported in table 1 were performed by the Southwestern Radiological Health Laboratory at Las Vegas, Nevada. Previous results were last reported in *Radiological Health Data*, October 1962.

REFERENCE

(*1*) Straub, C. P.: Statement on New Data on Uptake in Milk, Food, and Human Bone, *Joint Committee on Atomic Energy Hearings on Fallout From Nuclear Weapons Tests*, *2*:990 (May 1959).

Previous coverage in *Radiological Health Data:*

Period	*Issue*
October–November 1959	*June 1960*
October–December 1959	*July 1960*
Fourth quarter 1959, First and second quarters 1960	*August 1961*
October 1961-April 1962	*October 1962*

SECTION V.—OTHER DATA

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission regularly receives reports from its contractors on the environmental levels of radioactivity in the vicinity of major Commission installations. These reports include data from routine monitoring programs where operations are of such a nature that plant perimeter surveys are required.

Summaries of the environmental radioactivity data for 22 AEC installations have periodically appeared in *Radiological Health Data* since November 1960. A summary of the Savannah River Plant report for calendar year 1962 follows.

Savannah River Plant

Calendar Year 1962

E. I. du Pont de Nemours
Aiken, South Carolina

The Savannah River Plant (SRP) maintains a continuous monitoring program to determine the concentrations of radioactive materials in a 1200-square-mile area outside the plant perimeter. Included in this area are parts of Aiken, Barnwell, and Allendale Counties in South Carolina and Richmond, Burke, and Screven Counties in Georgia. This program, initiated in 1951 prior to plant operations, is carried out by the Health Physics Section of E. I. du Pont de Nemours and Company, prime contractor for operation of the plant for the Atomic Energy Commission.

Although SRP discharges some gaseous and liquid waste to the environment, the releases are controlled to assure adequate dispersal so that the offsite concentration of radioactive materials is below the Radioactivity Concentration Guides (RCG's)* shown in table 1. Continuous surveillance of the Savannah River Plant provides information useful both as a measure of the effectiveness of plant controls and as evidence of the strict adherence to the recommended RCG.

Atmospheric Monitoring

Continuous air and rainwater samples are collected at 15 monitoring stations. These stations, which include 5 locations (A—E) at the plant perimeter and 10 locations approximately 25 miles from the center of the plant are spaced so that a measurable plant release of radioactivity to the air would be detected regardless of prevailing wind conditions (see figure 1). Four additional air monitoring stations are operated approximately 100 miles from the plant at Savannah and Macon, Georgia, and Columbia and Greenville, South

* The Radioactivity Concentration Guide (RCG)—a frame of reference against which environmental contamination levels can be compared—is the concentration in the environment (air, drinking water, and food) which is determined to result in organ doses equal to the recommended Radiation Protection Guide (RPG) levels. The Radiation Concentration Guides used in this report are based on the permissible concentrations recommended by the National Committee on Radiation Protection (NCRP) and the recommendations of the Federal Radiation Council.

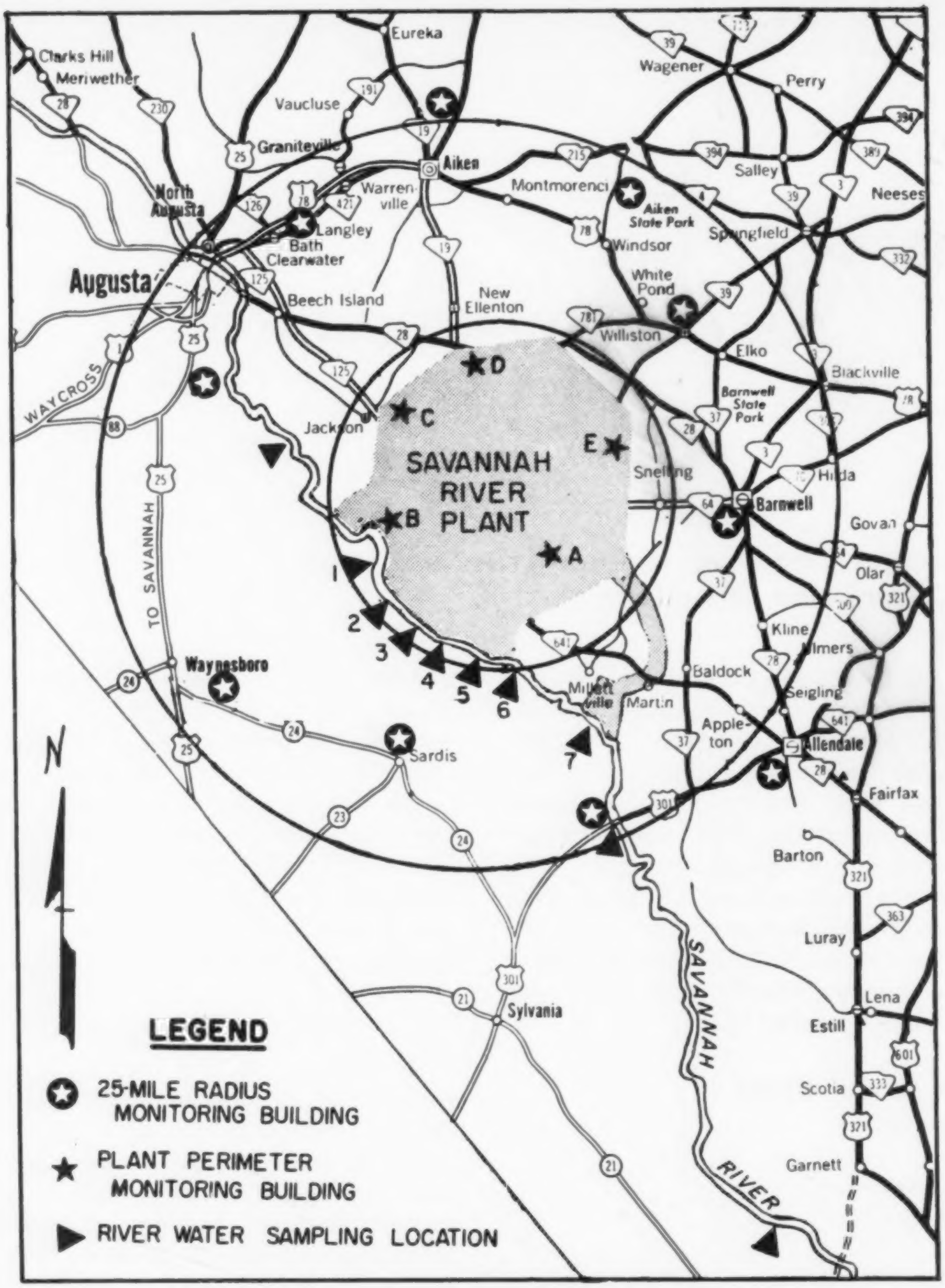

FIGURE 1.—ENVIRONMENTAL SAMPLING LOCATIONS, SAVANNAH RIVER PLANT

Carolina (see figure 2). At this distance, the effect of SRP operations is minimal, and, therefore, these facilities serve as "reference points" for determining background levels of activity. The complete system of 19 stations permits a comprehensive surveillance of atmospheric radioactivity and differentiation between weapons testing fallout and plant releases. The average concentrations of radioactivity in air and rainwater are given in tables 2 and 3.

The levels of radioactivity observed in air and in rainwater were attributed to fallout, as the radioactivity concentrations showed no correlation to plant releases.

TABLE 1.—RADIOACTIVITY CONCENTRATION GUIDES USED BY THE SAVANNAH PLANT

Measurement	RCG
Radioactivity in air	
alpha emitters	0.04 pc/m³
nonvolatile beta emitters	100 pc/m³
iodine-131	100 pc/m³
Radioactivity in rainwater*	
alpha emitters	10 pc/liter
nonvolatile beta emitters	3,000 pc/liter
iodine-131	100 pc/liter
Radioactivity in milk	
tritium	300,000 pc/liter
iodine-131	100 pc/liter
strontium-90	100 pc/liter
Radioactivity in public water supplies	
alpha emitters	10 pc/liter
nonvolatile beta emitters	3,000 pc/liter
Radioactivity in Savannah River water	
alpha emitters	10 pc/liter
nonvolatile beta emitters	3,000 pc/liter
tritium	300,000 pc/liter
strontium-90	90 pc/liter

* Assuming use as drinking water.

TABLE 2.—RADIOACTIVITY IN AIR

[Average concentrations in pc/m³]

Period	Source of samples	Alpha	Non-volatile beta	Iodine-131
First half 1962	plant perimeter	0.0008	3.9	*
	25-mile radius	0.0008	3.9	*
	100-mile radius	0.0010	3.9	*
Second half 1962	plant perimeter	0.0007	3.3	0.07
	25-mile radius	0.0008	3.4	0.06
	100-mile radius	0.0011	3.9	0.07

* Below the minimum detection limits (0.02 pc/m³).

TABLE 3.—RADIOACTIVITY IN RAINWATER

[Average concentrations in pc/liter]

Period	Source of samples	Alpha	Non-volatile beta	Iodine-131
First half 1962	plant perimeter	0.4	1,400	*
	25-mile radius	0.3	1,300	*
Second half 1962	plant perimeter	0.4	830	36
	25-mile radius	0.4	920	29

* Below the minimum detection limits (9 pc/liter).

Milk

Milk samples were collected from dairies and farms within a 50-mile radius of the Plant, and were analyzed weekly for tritium and iodine-131 and monthly for strontium-90. Average concentrations of tritium, iodine-131 and strontium-90 are given in table 4.

The estimated exposure to a child's thyroid for calendar year 1962 from consumption of one liter of local dairy milk per day was less than 25 percent of the 0.5 rem per year guidance value suggested by the Federal Radiation Council. The exposure to an adult would be one-tenth that of a child on a thyroid weight basis.

FIGURE 2.—DISTANT AIR MONITORING STATIONS, SAVANNAH RIVER PLANT

TABLE 4.—RADIOACTIVITY IN MILK

[Average concentrations in pc/liter]

Analysis	Number of locations	First half 1962	Second half 1962
Tritium			
Farms	4	6,000	5,000
Local dairies	6	4,000	4,000
Major distributors	1	3,000	3,000
Iodine-131			
Farms	4	11	87
Local dairies	6	7	27
Major distributors	1	<6	24
Strontium-90			
Farms	5	48	43
Local dairies	6	19	16
Major distributors	3	19	16

The higher concentrations of strontium-90 in milk of farm cows were attributed to the feeding habits. These cows generally received little commercial feed but grazed on topshoots or shallow-rooted grasses, both susceptible to fallout contamination. Dairy cows, on the other hand, received less pasture grass and more dried silage and commercial feed. The same relationship seems to be true for tritium and iodine-131.

Vegetation

Bermuda grass, because of its importance as a pasture grass for dairy herds and its year-round availability, was selected for analysis of radioactive contamination.

Average concentrations of alpha emitters and nonvolatile beta emitters found on vegetation collected at the air monitoring locations shown in figure 2 are summarized in table 5.

TABLE 5.—RADIOACTIVITY IN VEGETATION (BERMUDA GRASS)

[Average concentrations in pc/gm]

Period	Source of sample	Alpha	Non-volatile beta
First half 1962	Plant perimeter	0.18	290
	25-mile radius	0.18	320
Second half 1962	Plant perimeter	0.10	90
	25 mile radius	0.08	80

Algae and Fish in Savannah River

Determination of radioactivity concentrations in algae is important because algae are concentrators of specific radionuclides and also have an important relationship in the food chain of aquatic organisms. Indigenous algae samples were collected weekly upstream from, adjacent to, and downstream from the plant. The average nonvolatile beta concentrations are given in table 6. Some correlation of plant effluent entry into the river is indicated by the lower upstream values Fish taken from the river showed negligible plant-contributed radioactivity.

TABLE 6.—NONVOLATILE BETA IN SAVANNAH RIVER ALGAE AND FISH

[Average concentration in pc/gm]

Period	Location	Nonvolatile beta	
		Algae	Fish (flesh)
First half 1962	Adjacent to plant	165	5
	Upstream (3 mi.)	100	4
	Downstream (10 mi.)	135	4
Second half 1962	Adjacent to plant	445	8
	Upstream (3 mi.)	45	4
	Downstream (10 mi.)	140	6

Water Monitoring

Communities in the vicinity of SRP obtain water from deep wells or surface streams. Public water samples are collected monthly from 14 surrounding towns. The Savannah River is sampled continuously at 7 locations. Six of the locations are shown in figure 1; the seventh is 60 miles downstream from the plant.

Average concentrations of alpha and beta activity in public and Savannah River water are presented in table 7. The values shown indicate that plant operations contribute small amounts of radioactivity to the Savannah River, and the resulting concentrations are far below RCG values.

TABLE 7.—RADIOACTIVITY IN WATER

[Average concentrations in pc/liter]

Period	Source of samples	Alpha	Non-volatile beta	H^3	Sr^{90}
First half 1962.	Public water supplies	1.2	10	—	—
	Savannah River water				
	3 miles upstream	0.3	38	*	0.8
	10 miles downstream	0.2	52	7,500	1.2
Second half 1962.	Public water supplies	1.2	7	—	1.2
	Savannah River water				
	3 miles upstream	0.1	12	710	0.8
	10 miles downstream	0.1	35	13,000	1.7

* Less than sensitivity of analysis (600 pc/liter).

External Gamma Radiation Levels

Environmental gamma radiation levels are measured by portable ion chamber dosimeters at each of the 15 air monitoring stations shown in figure 1. The average gamma radiation doses for calendar year 1962 were 0.44 mr per 24 hours at the plant perimeter stations and 0.42 mr per 24 hours at the 25 mile radius stations.

Discussion

During 1962, the low levels of radioactivity released to the environs by the SRP were for the most part too low to be distinguished from natural background radiation levels, or were obscured by world-wide fallout from nuclear weapons testing.

Previous coverage in *Radiological Health Data:*

Period	*Issue*
1959 and first quarter 1960	*December 1960*
Second and third quarters 1960	*May 1961*
Fourth quarter 1960	*August 1961*
First and second quarters 1961	*February 1962*
Third and fourth quarters 1961	*September 1962*

Whole Body Counting

Whole body counters are being applied where the detection of low levels of radioactivity in the human body is of prime interest. One example is the evaluation of hazards to radiation workers and the general population. These instruments are also used in human physiological and pathological investigations as well as in studies related to counter design for special purposes. Discussion and presentation of whole body counting results in previous issues of *RHD* have been limited to medical research programs employing thallium-activated sodium iodide crystals or liquid scintillation solutions.

CESIUM–137 IN MAN
September 1962 through December 1962

U.S. Army Medical Research Unit, Landstuhl, Germany

In 1955, cesium–137 was first detected in man by the Argonne National Laboratory (*1*). It emits a 0.661 Mev gamma photon, which can be quantitatively determined by a properly calibrated whole body counter. Since cesium is physiologically similar to potassium, and for the most part exists intracellularly, the cesium–137 levels are usually expressed in picocuries per gram of potassium. The whole body counting facility at the Medical Research Unit, Landstuhl, Germany, in its program for measuring the cesium–137 levels in man, utilizes a liquid scintillation counter (*2*). Results of analyses performed at Landstuhl from September through December 1962 are presented in table 1 and appear in figure 1 together with similar data collected since July 1960.

TABLE 1.—ASSAYS PERFORMED AT THE U. S. ARMY MEDICAL RESEARCH UNIT LANDSTUHL, GERMANY

Date	Number of subjects	Residence	Cesium–137 pc/g K (average)	Percent MPBB[1]
September 1962	381	West Germany	51	0.24
October 1962	238	West Germany	61	0.28
November 1962	606	West Germany	52	0.24
December 1962	110	West Germany	49	0.22

[1] Percent maximum permissible body burden was calculated using 3 μc of cesium–137 as the general population maximum permissible whole body burden and 140 grams of potassium in the body of the "standard man." (See pp. 187 and 192 of Radiological Health Handbook, Office of Technical Services, U. S. Department of Commerce (1960), price $3.75.)

REFERENCES

(*1*) Miller, C. E., and L. D. Marinelli: Gamma-Ray Activity of Contemporary Man, *Science, 124*:122–3 (20 July 1956).

(*2*) Anderson, E. C., F. N. Hays, and R. D. Hiebert: Walk-in Human Counter, *Nucleonics, 16*:106 (August 1958).

Recent coverage in *Radiological Health Data:*

Period	*Issue*
First quarter 1961	*July 1961*
Second quarter 1961	*October 1961*
Third quarter 1961	*January 1962*
First quarter 1962	*August 1962*
Second quarter 1962	*October 1962*
Third quarter 1962	*December 1962*
July 1958–September 1962	*April 1963*

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UNITS AND EQUIVALENTS

Symbol	Unit	Equivalent
Bev	billion electron volt	
cpm	count per minute	
dpm	disintegration per minute	
g	gram	
kg	kilogram	1 kg = 1000 gm = 2.2 pounds
km^2	square kilometer	
kvp	kilovolt peak	
m^3	cubic meter	1 m^3 = 1000 liters
ma	millampere	
mas	milliampere-second	
Mev	million electron volts	
mi^2	square mile	
ml	milliliter	
mm	millimeter	
mrad	millirad	
mrem	millirem	
mr/hr	milliroentgen per hour	
mμc	millimicrocurie	1 mμc = 1 nc
nc	nanocurie	1 nc = 1000 pc = 1 mμc = 10^{-9} curies
nc/m^2	nanocurie per square meter	1 nc/m^2 = 1 mμc/m^2 = 1,000 $\mu\mu$c/m^2 = 1 mc/km^2 = 2.59 mc/mi^2
pc	picocurie	1 pc = 1 $\mu\mu$c = 10^{-12} curies
r	roentgen	
$\mu\mu$c	micromicrocurie	1 $\mu\mu$c = 2.22 dpm

INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

Multiples and submultiples	Prefixes	Symbols	Pronunciations
10^{12}	tera	T	tĕr′ a
10^{9}	giga	G	jĭ′ ga
10^{6}	mega	M	mĕg′ a
10^{3}	kilo	k	kĭl′ o
10^{2}	hecto	h	hĕk′ to
10	deka	da	dĕk′ a
10^{-1}	deci	d	dĕs′ ĭ
10^{-2}	centi	c	sĕn′ tĭ
10^{-3}	milli	m	mĭl′ ĭ
10^{-6}	micro	μ	mī′ kro
10^{-9}	nano	n	năn′ o
10^{-12}	pico	p	pē′ co
10^{-15}	femto	f	fĕm′ to

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